APPENDIX A

Interdisciplinary Team Analysis Record Checklist & Resources Considered and Dismissed from Further Analysis

INTERDISCIPLINARY TEAM CHECKLIST

Project Title: Monument Butte EIS

NEPA Log Number: DOI-BLM-UT-G010-2009-0217-EIS

File/Serial Number: various oil and gas lease numbers

Project Lead: Mark Wimmer/Third Party: Kleinfelder

Determination of STAFF: (Choose one of the following abbreviated options for the left column.)

NP = not present in the area impacted by the proposed or alternative actions

NI = present, but not affected to a degree that detailed analysis is required

PI = present with potential for significant impact analyzed in detail in the EA; or identified in a DNA as requiring further analysis

NC = (DNAs only) actions and impacts not changed from those disclosed in the existing NEPA documents cited in Section C of the DNA form.

DETERMINATION	RESOURCE	RATIONALE FOR DETERMINATION*	SIGNATURE	DATE
PI	Air Quality (including greenhouse gas emissions)	Potential impacts to air quality from wells, compressors, and dust from construction. Emissions inventory and modeling needed to determine compliance with NAAQS (including ozone) and impacts in relation to other applicable standards.	Stephanie Howard	6/12/2009
PI	Areas of Critical Environmental Concern	Potential impacts to relevance and importance criteria within Pariette Wetland ACEC.	Jason West	6/17/2009
NP	BLM natural areas	None Present as per GIS and RMP Review	Jason West	6/17/2009
PI	Cultural Resources	Potential impact to cultural resources from construction of wells, compressors, access roads and dust from construction. Class III surveys required on each site-specific proposed project.	Gabrielle Elliott	6/12/2009
NI	Environmental Justice	No minority or disadvantaged populations will be disproportionately adversely affected by the proposed action or alternatives.	Stephanie Howard	6/12/2009
NI	Farmlands (Prime or Unique)	Soil surveys have not been completed for Duchesne County, so no prime or unique farmlands have been designated. Prime and unique farmlands in Uintah County are irrigated lands and orchards. None of these types of lands occur on BLM land in the project area.	Stephanie Howard	6/12/2009
PI	Floodplains	There are numerous floodplains that will potentially be affected by the Proposed Action. Most of the channels are intermittent washes and perennially flowing tributaries of the Pariette Draw, and the associated floodplains will undergo changes if wells are placed within these zones. This is based on GIS data layers of the proposed action, and from field visits on many occasions in this project area.	James Hereford II	6/16/2009
NI	Fuels / Fire Management	No ongoing or planned fuel projects within the Proposed Action Project Area. No expected impact to fire suppression efforts since the Project Area is in an area of low fire occurrence.	Steven Strong	6/15/2009
PI	Geology / Mineral Resources / Energy Production	The ongoing development of oil and gas resources for the proposed action is in accordance with the VFO ROD (2008). Gilsonite, tar sands, oil shale, and areas of combined hydrocarbons could be affected by the project. Compliance with	Stephanie Howard	11/5/2013

DETERMINATION	RESOURCE	RATIONALE FOR DETERMINATION*	SIGNATURE	DATE
		Onshore Oil and Gas Order No. 2 during drilling and completion operations will protect non-oil and gas mineral resources.		
PI	Invasive Plants / Noxious Weeds	Surface disturbance increases weed recruitment from seeds already present in the soil seed reservoir, and from fresh seeds vectored in by wind, animals, vehicles, and heavy equipment. Company is required to prepare a weed control program and, if planning to use pesticides, submit a Pesticide Use Proposal.	Clayton Newberry	6/15/2009
PI	Lands / Access	ROWs would be required for power lines, pipelines, and roads located off of the unit/lease in the Project Area. ROWs would be required for power lines and pipelines within the unit/lease that are operated by 3rd party holders in the Project Area. Main transportation pipelines would require a ROW within the unit/lease regardless of who owns it. Any commercial facilities located within the unit/lease would require a ROW within the Project Area. Site-specific plans for pipelines, power lines, and roads would be included as part of Newfield's individual APDs and/or ROW applications (3rd party) and would be subject to approval from the appropriate SMA. Newfield would need to coordinate with the Duchesne and Uintah Counties for crossing, upgrading, and/or maintenance of county roads as shown on their county transportation maps. Duchesne and Uintah Counties would need to be contacted for the necessary county permits. ROW holders are present in the Project Area and would be notified by BLM per site-specific proposals.	Cindy McKee	6/26/2009
PI	Livestock Grazing	The amount of surface disturbance proposed and the cumulative surface disturbance from the past decade or more should be quantified for lost forage and the number of Animal Unit Months reduced for each allotment in the project area. Additionally from direct surface disturbance, indirect disturbance from non-compliance and invasive vegetation would reduce forage availability for livestock and wildlife.	Stan Olmstead	6/23/2009
NP	Native American Religious Concerns	Based on data layers of cultural resources areas recorded, there are no known concerns.	Gabrielle Elliott	6/12/2009

DETERMINATION	RESOURCE	RATIONALE FOR DETERMINATION*	SIGNATURE	DATE
PI	Paleontology	The middle to upper Uinta Formation outcrops at the surface in the area of the proposed action. The PFYC for the area is between 4 and 5. Paleontological surveys are required for all surface disturbing activities.	Robin L Hansen	6/19/2009
PI	Rangeland Health Standards and Guidelines	Rangeland Health surveys were conducted in 2007 and 2008 within the Project area and resulted in slight to moderate alteration from the expectation of healthy rangeland. However, with the large amount of surface disturbance proposed, it would be expect that rangeland health would be reduced by direct and indirect impacts, surface disturbance, non-compliance issues, fugitive dust, and invasive vegetation. Grazing operations may need to be reduced or eliminated from the Project Area as a result.	Stan Olmstead	6/23/2009
PI	Recreation	There would be potential impacts to recreation within Pariette Wetlands as well as the potential to impact designated motorized routes. Impacts would be site specific and would not be limited to affecting visitor experience from visual and audio intrusion particularly within Pariette Wetlands.	Jason West	6/17/2009
PI	Socioeconomics	Potential impacts to social and economic status of Duchesne and Uintah counties are expected due to size of project. Impacts include labor needs, tax revenues, etc.	Stephanie Howard	6/12/2009
PI	Soils	Potential impacts to soils from surface disturbing actions of well pads, roads, and pipelines.	Steven Strong	6/15/2009
PI	Special Status Animal Species other than USFWS candidate or listed species (e.g. migratory birds)	Crucial deer fawning / elk calving habitat along Pariette Wetlands, Raptors in general (i.e. Bald eagle roosts in Pariette Wetlands and also Burrowing owl nesting habitat), Greater Sage-grouse (brooding and wintering grounds including one historic lek site), Mountain plover nesting habitat, Bird Habitat Conservation Area (Pariette Wetlands #26), Water fowl and upland game (Pariette Wetlands), State sensitive bat species, Herpetiles, Migratory birds in general (PIF species), White-tailed prairie dog,	Brandon McDonald	6/15/2009

DETERMINATION	RESOURCE	RATIONALE FOR DETERMINATION*	SIGNATURE	DATE
		In addition, impacts to Flannelmouth sucker, Bluehead sucker, Roundtail chub are anticipated (water depletion from the Green River, possible contamination, and sedimentation into the floodplains).		
NP	Special Status Plant Species other than USFWS candidate or listed species	None present according to GIS layer, repeated forays throughout this area, and staff familiarity with BLM sensitive species and their habitat preferences.	Clayton Newberry	6/15/2009
PI	Threatened, Endangered or Candidate Animal Species	Impacts to Bonytail, Colorado pikeminnow, Humpback chub, and razorback sucker are anticipated (water depletion from the Green River, possible contamination, and sedimentation into the floodplains).	Brandon McDonald	6/15/2009
PI	Threatened, Endangered or Candidate Plant Species	Threatened Uinta Basin hookless cactus and Pariette hookless cactus (*Sclerocactus wetlandicus, S. brevispinus*) and their putative hybrids grow in this area.	Clayton Newberry	6/15/2009
PI	Vegetation	Project Area consists of routine salt desert scrub species, such as are common in Uinta Basin and elsewhere in Intermountain area—mostly ARNO4, ATCA, ATCO, ATCO4, ATGA, CLLU2, ERNAT, GRSP, GUSA2, HECO26, LAOC, OECA10, OPPO, ORHY, PLIN7, PLJA, SAVE4, TESP2. Some individuals might be lost in project construction.	Clayton Newberry	6/15/2009
PI	Visual Resources	VRM Class II, III, and IV identified within the proposed Project Area.	Jason West	6/17/2009
NI	Wastes (hazardous or solid)	No chemicals subject to reporting under SARA Title III in amounts greater than 10,000 pounds would be used, produced, stored, transported, or disposed of annually in association with the project. Trash and other waste materials would be cleaned up and removed immediately after completion of operations.	Stephanie Howard	6/12/2009
PI	Waters of the U.S.	Waters of the U.S. (WOUS) shall be identified, mapped, and avoided to the maximum extent possible. Unavoidable impacts to WOUS will require a USACE permit. Road crossings on larger waterways should be designed for 100-year flow events (as opposed to the BLM Gold Book standard of 25-year flow events) due to the arid area and high intensity precipitation events that occur. Well pads and other associated infrastructure should avoid WOUS, associated floodplains, and may require onsite inspection	Sue Nall	6/18/2009

DETERMINATION	RESOURCE	RATIONALE FOR DETERMINATION*	SIGNATURE	DATE
		by the USACE prior to construction (Sue Nall @ 970-243-1199 #16).		
PI	Water Quality (surface, including hydrologic resources; e.g. stormwater)	The Proposed action has the potential to affect surface water quality, because of the number of channels in the area of concern. These channels could be subject to oil spills and other events that could affect surface water quality directly.	James Hereford II	6/16/09
PI	Water Quality (ground)	USDW's may be affected by the proposed action. Compliance with Onshore Orders and BLM Instruction Memorandum (IM) No. UT 2010-055 is required to minimize potential damage.	Robin Hansen	6/19/09
PI	Wetlands / Riparian Zones	The Proposed action has the potential to negatively affect the Pariette ACEC wetlands area, and the riparian that has been mapped along the Pariette Draw perennial water flow zones in the upper part of the Draw. Additional wetland mapping may be required by the USACE for avoidance purposes.	James Hereford II Sue Nall	6/16/2009
PI	Wild and Scenic Rivers	Lower Green River Suitable section (2008 RMP)	Jason West	6/17/2009
NP	Wild Horses and Burros	Following a review of VFO GIS data and the VFO RMP, no herd management or herd areas are located in the Project Area. Therefore, this resource/issue will not be carried forward for analysis.	Mark Wimmer	06/24/2009
NP	Wilderness	Not Present as per Vernal GIS and RMP review	Jason West	6/17/2009
NP	Wilderness Study Areas	Not Present as per Vernal GIS and RMP review	Jason West	6/17/2009
PI	Woodland / Forestry	Clearing for well locations, roads, and pipelines could impact forest and woodlands resources. Woodland products should be removed in such a way that they can be used, and the BLM should be compensated for their value.	David Palmer	6/15/2009

FINAL REVIEW:

Follow the italicized instructions below and then delete the asterisks"" in the checklist, this sentence, and the instructions.*

REVIEWER TITLE	SIGNATURE	DATE	COMMENTS
NEPA / Environmental Coordinator			
Authorized Officer			

**Rationale for Determination is required for all "NIs" and "NPs." Write issue statements for "PIs"*

AIR QUALITY TECHNICAL SUPPORT DOCUMENT for the PROPOSED MONUMENT BUTTE OIL AND GAS DEVELOPMENT PROJECT

JULY 27, 2015

AIR QUALITY TECHNICAL SUPPORT DOCUMENT for the PROPOSED MONUMENT BUTTE OIL AND GAS DEVELOPMENT PROJECT

Kleinfelder Job No. 116133-3

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1 EXECUTIVE SUMMARY

This Air Quality Technical Support Document (AQTSD) describes the process used to conduct an air quality impact assessment (AQIA) for the proposed Newfield Exploration Company (Newfield) Monument Butte Oil and Gas Development project.

1.1 Introduction to the Project and AQIA

The proposed project will be implemented in the Monument Butte Project Area (MBPA) which is located within the Greater Monument Butte Unit in southeast Duchesne County and southwest Uintah County in the state of Utah. The MBPA is shown on Figure 1-1, which is located at the end of this Section.

There are four alternatives for the proposed project:

- Alternative A: Proposed Action
- Alternative B: No Action
- Alternative C: Field-Wide Electrification
- Alternative D: Resource Protection (Agency Preferred Alternative)

The Proposed Action (Alternative A) is to drill, develop, and operate up to 5,750 oil and gas wells in the MBPA, along with the required infrastructure. In summary, the Proposed Action includes:

- Drill, develop, and operate up to 3,250 Green River oil wells and 2,500 deep gas wells on existing and new well pads
- Construct additional roads and pipelines to serve the wells
- Construct 20 new gas compressor stations to serve the deep gas wells
- Expand 3 existing compressor stations and add one new compressor station to serve the oil wells
- Construct a new 50 million standard cubic feet per day (MMscf/d) centralized gas processing plant
- Construct 7 new and expand 6 water treatment and injection facilities
- Construct up to 12 new gas oil separation plants (GOSPs) for oil and produced water collection

- Develop one fresh water collector well for water flood operations and add 6 water pump stations

The Proposed Action includes a large number of Applicant Committed Environmental Protection Measures (ACEPMs) that reduce overall environmental impact and the potential air quality impacts. The ACEPMs are listed in Section 2.

Under the No Action Alternative, the proposed project would not be implemented but oil and gas development in the MBPA would continue to occur on private and state lands and on Bureau of Land Management (BLM) administered lands as previously authorized through other Environmental Impact Statement (EIS) Records of Decision (RODs). A total of 788 wells (579 oil wells and 209 gas wells) would be developed under the No Action Alternative. The ACEPMs and other measures that would be taken by Newfield under the Proposed Action would not occur under the No Action Alternative. However, promulgated regulatory requirements apply to both the Proposed Action and No Action Alternatives.

Under Alternative C, Newfield would implement field-wide electrification of various well field components (e.g., pumpjack engines). This Alternative would include the same oil and gas operations as Alternative A, but add 11 substations that consist of two 20 megawatt electric (MWe) gas turbine generators and one 10 MWe steam turbine generator at each substation (50 MWe per substation) for a total generation capacity in the MBPA of 550 MWe. Overhead transmission and distribution lines would also be added to distribute the electrical energy from the substations to the end use.

Alternative D is similar to Alternative A, but reduces the amount of initial surface disturbance in order to protect sensitive areas within the MBPA. Alternative D would result in at most a total of 5,750 wells being drilled, developed, and operated (3,250 oil and 2,500 deep gas).

The Proposed Action and Alternatives are further described in Section 2 of this AQTSD.

In order to conduct the AQIA, first the existing background air quality was determined along with the evaluation criteria that will be used to evaluate the potential ambient air quality impact of the Proposed Action and Alternatives. Then emission estimates of criteria and key hazardous air pollutants were developed for each of the Alternatives. For Alternative A, not only were emission estimates developed for the maximum impact year when all of the proposed wells were developed and operating, annual development emission estimates were made for a ten-year period, 2012 through 2022.

Once the emissions were determined, dispersion models were used to evaluate the potential impact in the near field (less than 50 kilometers (km) from the sources) and far field (i.e., potential impacts at distant Class I areas, Class II areas, and sensitive lakes).

The evaluation criteria were the National Ambient Air Quality Standards (NAAQS) for criteria pollutants, toxic screening levels and other reference concentrations for hazardous air pollutants, and air quality related value (AQRV) thresholds specified by the Federal Land Managers for the Class I areas, sensitive Class II areas, and sensitive lakes. The evaluation criteria are discussed in detail in Section 3. Section 3 also presents the pre-project, background ambient air quality conditions in the MBPA.

1.2 Proposed Project and Alternatives Emissions

Table 1-1 summarizes the emissions for the four alternatives. Details are provided in Section 4 and the appendices.

Table 1-1
Proposed Action and Alternatives Emissions

Pollutant	Alternative A: Proposed Action (tpy)	Alternative A: Proposed Action Only through 2022[a] (tpy)	Alternative B: No Action (tpy)	Alternative C: Field-Wide Electrification (tpy)	Alternative D: Resource Protection (tpy)
Criteria Pollutants					
NO_x	5,690.1	744.7	1,817.3	1,994.8	5,635.4
CO	8,523.8	----	1,497.4	1,949.3	8,495.0
VOC	10,360.9	4833.0	2,116.9	8,366.2	8,752.6
SO_2	14.4	----	2.8	9.4	14.2
PM_{10}	2,903.6	----	810.1	2,709.0	2,878.5
$PM_{2.5}$	617.0	----	157.0	422.3	609.8
Hazardous Air Pollutants					
Benzene	62.57	----	13.75	53.27	57.46
Toluene	75.90	----	28.04	72.44	71.18
Xylene	44.67	----	43.26	43.78	43.16
Formal-dehyde	380.99	----	49.80	9.79	380.95
Acrolein	45.60	----	6.33	0.087	45.60
Total HAPs	1,004.73	----	227.61	480.17	911.96
Greenhouse Gases					
CO_2	2,830,690	----	461,805	3,134,441	2,779,876
CH_4	12,587	----	1,686	12,582	12,218
N_2O	6.13	----	1.45	6.71	6.03
GWP	3,096,936	----	497,665	3,400,752	3,038,339

[a] Only NOx and VOC emissions were calculated for the annual emission analysis.

1.3 Substantial Increase in Emissions Assessment

As indicated, under the No Action Alternative, oil and gas development will continue in the MBPA under previously authorized RODs on federal mineral estates and on state and private lands. For purposes of assessing potential ozone impacts, the Proposed Action emissions were compared to the No Action Alternative emissions to determine if there would be a substantial increase in ozone precursor (NOx and VOC) emissions. For purposes of this document, "substantial increase" is defined as emissions from the Proposed Action that are greater than emissions from the No Action Alternative. As shown in Table 1-1, annual development of the Proposed Action can occur until approximately early calendar year 2021 without total NO_x and VOC emissions exceeding emissions that would occur under the No Action Alternative. As shown in Section 4 and discussed in Section 6, by calendar year 2021 there could be a net increase of over 1,000 oil and gas wells in the MBPA and not cause NO_x plus VOC emissions to exceed the No Action Alternative emissions. There would be no substantial increase in NOx emissions alone through 2022. There could be a substantial increase of VOC emissions by late 2019 (i.e., VOC emission increases from annual development of the Proposed Action could exceed emission increases under the No Action Alternative). This level of development can occur because Newfield will implement a number of emission reducing measures and ACEPMs in order to reduce emissions from existing and future oil and gas wells, and because the existing level of infrastructure can service the additional wells.

1.4 Near Field Dispersion Modeling and Results

For near field impacts, five different source configurations were developed in order to assess the maximum potential impact of construction and development emissions as well as operation (production) emissions. The modeling scenarios are as follows and are discussed in detail in Section 5:

- Alternative A – Proposed Action: Well construction and development
- Alternative A – Proposed Action: 20-acre downhole spacing oil well operations
- Alternative A – Proposed Action: 40-acre surface spacing gas well operations
- Alternative C – Field Wide Electrification: 20-acre downhole spacing oil well operations
- Alternative C – Field Wide Electrification: 40-acre surface spacing gas well operations

Construction and development activities are essentially the same under all of the Alternatives and thus only one modeling scenario is needed to assess the impact of construction and development emissions.

The United States Environmental Protection Agency (USEPA) recommended AERMOD dispersion model was used with five years of meteorological data (2005 – 2009) collected at Vernal Utah, and obtained from the Utah Department of Environmental Quality – Division of Air Quality (UDAQ). The impact modeling methodology is further described in Section 5 and the results are presented in Section 7.

The maximum near field impacts for the criteria pollutants are shown in Table 1-2. The maximum impacts for all except PM_{10} and $PM_{2.5}$ were from well or infrastructure operations. The maximum short term PM_{10} and $PM_{2.5}$ impacts were from construction and development of the well field. The maximum CO 1-hour impacts are from the 40-acre surface spacing gas well operations from Alternative A modeling scenario, while the CO 8-hour, NO_2 and SO_2 impacts are from the 20-acre downhole spacing oil well operations from Alternative A.

Table 1-2
Maximum Potential Project Impacts

Pollutant	Averaging Period	Ambient Air Concentration (µg/m^3)			
		Maximum Modeled Impact	Background	Total	NAAQS
CO	1-hour	265	2,641	2,906	40,000
	8-hour	137	1,657	1,794	10,000
NO_2	1-hour	106.9 [a]	65.7	172.6	188
	Annual	16.5	8.8	25.3	100
SO_2	1-hour	0.7	20.1	20.8	196
	3-hour	0.6	14.3	14.9	1,300
PM_{10}	24-hour	72.5	18.7	91.2	150
$PM_{2.5}$	24-hour	14.3	19.7	34.0	35
	Annual	1.4	6.6	8.0	12

[a] Assumes NO to NO_2 conversion of 80%

The maximum air toxics near field impacts for non-carcinogenic impacts are shown in Table 1-3 and potential carcinogenic impacts are shown in Table 1-4. The maximum impacts for 1-hour acrolein, annual acrolein, annual formaldehyde, and annual benzene are from well operations in the 20-acre downhole spacing oil well operations scenario from Alternative A. The maximum impacts for 1-hour formaldehyde and 1-hour benzene are from the 40-acre surface spacing gas well operations from Alternative A modeling scenario. The impacts of acrolein, benzene, and formaldehyde are the greatest with respect to the RELs and RfCs, and thus are the only three reported in Table 1-3. However, emissions from all hazardous air pollutants are quantified.

Table 1-3
Maximum Potential Non-Carcinogenic REL and RfC Impacts

HAP	Modeled Maximum 1-Hour Impact (μg/m³)	REL (μg/m³)	1-Hour Toxic Screening Levels [a] (μg/m³)	Modeled Maximum Annual Impact (μg/m³)	RfC (μg/m³)	Annual Toxic Screening Levels [b] (μg/m³)
Acrolein	1.50	2.5	23	0.18	0.35	--
Benzene	5.55	1,300	18	0.30	30	--
Formaldehyde	12.32	55	37	1.27	9.8	--

[a] The TSL for benzene is a 24-hour average, but the 1-hour concentration is conservatively compared to the TSL.
[b] The TSLs do not exist for annual averages.

Table 1-4
Maximum Potential Carcinogenic Risk

Exposure Scenario	HAP	Modeled Annual Impact (μg/m³)	Cancer Risk
MLE	Benzene	0.30	6.2×10^{-08} to 2.2×10^{-07}
	Formaldehyde	1.27	1.6×10^{-06}
	TOTAL MLE RISK		**1.8×10^{-6}**
MEI	Benzene	0.30	3.8×10^{-07} to 1.3×10^{-06}
	Formaldehyde	1.27	9.4×10^{-06}
	TOTAL MEI RISK		**1.1×10^{-05}**

1.5 Far Field Dispersion Modeling Results

Section 5 describes the details of the far field impact assessment methodology. The CALPUFF system of dispersion models was used for the far field assessment. One modeling scenario, Alternative A – Proposed Action, was modeled as this scenario has the maximum non-particulate emissions. The Class I and sensitive Class II areas evaluated include the following:

National Park Service (NPS) Class I Areas

- Arches National Park
- Black Canyon of the Gunnison National Park
- Canyonlands National Park
- Capitol Reef National Park
- Great Sand Dunes National Park and Preserve

- Mesa Verde National Park

USFS Class I Areas

- Eagles Nest Wilderness Area
- Flat Tops Wilderness Area
- La Garita Wilderness Area
- Maroon Bells-Snowmass Wilderness Area
- Mount Zirkel Wilderness Area
- Weminuche Wilderness Area
- West Elk Wilderness Area

NPS Class II Areas

- Colorado National Monument
- Dinosaur National Monument
- USFS Class II Areas
- Flaming Gorge National Recreation Area
- High Uintas Wilderness Area
- Holy Cross Wilderness Area
- Hunter/Frying Pan Wilderness Area
- Raggeds Wilderness Area

U.S. Fish and Wildlife Service Class II Areas

- Browns Park National Wildlife Refuge

Potential impacts in the noted Class I and sensitive Class II areas for criteria pollutants, regional haze, and acid deposition were assessed. In addition, potential change in acid neutralizing capacity (ANC) for sensitive lakes within these areas was also evaluated. Criteria pollutant impacts were compared to Prevention of Significant Deterioration (PSD) increments only as a point of information. The PSD program is a regulatory program implemented by the state of Utah, and the Proposed Action is not subject to the PSD program.

As discussed in Section 8, none of the far field impacts exceeded the PSD Class I and II increment evaluation criteria. Acid deposition at the sensitive lakes exceeded the Deposition Analysis Thresholds (which represent deposition in the absence of any anthropogenic activity and are used by Federal Land Managers to make project-specific decisions regarding adverse impacts); but none of the impacts exceeded the deposition impact thresholds. Regional haze impact evaluation thresholds were exceeded in the closest sensitive Class II areas. The largest impact was at Dinosaur National Monument where there were 131 days where the change in light extinction exceeded 0.5 deciviews (dV) The 98th percentile change in light extinction was 3.2 in Dinosaur National Monument. There was also one day in the Class I area of Arches National Park where the maximum change in light extinction exceeded 1.0 dV, but the 8th-high (98th percentile) was less than 1.0 dV.

1.6 Cumulative Impacts and Project Specific Ozone Modeling

The BLM has developed a Uinta Basin specific photochemical modeling platform as part of its air resource management strategy (ARMS) for the Uinta Basin. The ARMS modeling platform will replace CALPUFF modeling for far field project specific and cumulative impact analyses. The ARMS platform will also become the standard photochemical modeling system for assessing project specific and cumulative impacts on both near and far field ozone concentrations. The ARMS model became available between the Draft and Final EIS for the Monument Butte Oil and Gas Development Project. Accordingly, this AQIA developed for the Draft EIS did not explicitly model the far field cumulative potential impacts of the Proposed Action and Alternatives or the project-specific impact on local and distant ozone concentrations. Rather, the cumulative and ozone impact assessment conducted as part of the Greater Natural Buttes (GNB) Final Environmental Impact Statement (BLM 2012) was incorporated into the Newfield Monument Butte Oil and Gas Development Project EIS by reference. The GNB cumulative and ozone impact assessment evaluated the impacts of not only the proposed GNB project, but also the impacts of reasonable future development (RFD) in the Uinta Basin, and the RFD analyzed in the GNB FEIS explicitly included the Newfield Monument Butte Proposed Action. Because the ARMS modeling platform was not available at the time this AQIA was written, reviewing and incorporating the GNB analysis was the most appropriate method to evaluate potential ozone impacts and cumulative impacts of the Proposed Action and Alternatives. The results from GNB are not included in this AQTSD, but are summarized in the text of the Newfield Monument Butte EIS. Both cumulative and project specific modeling using the ARMS platform have been completed. The results of the project specific ARMS modeling for ozone are summarized in Chapter 4, Section 4.2.1.1.5 and the full modeling report is presented as Appendix K.

1.7 Adaptive Management Strategy for Potential Ozone Impacts

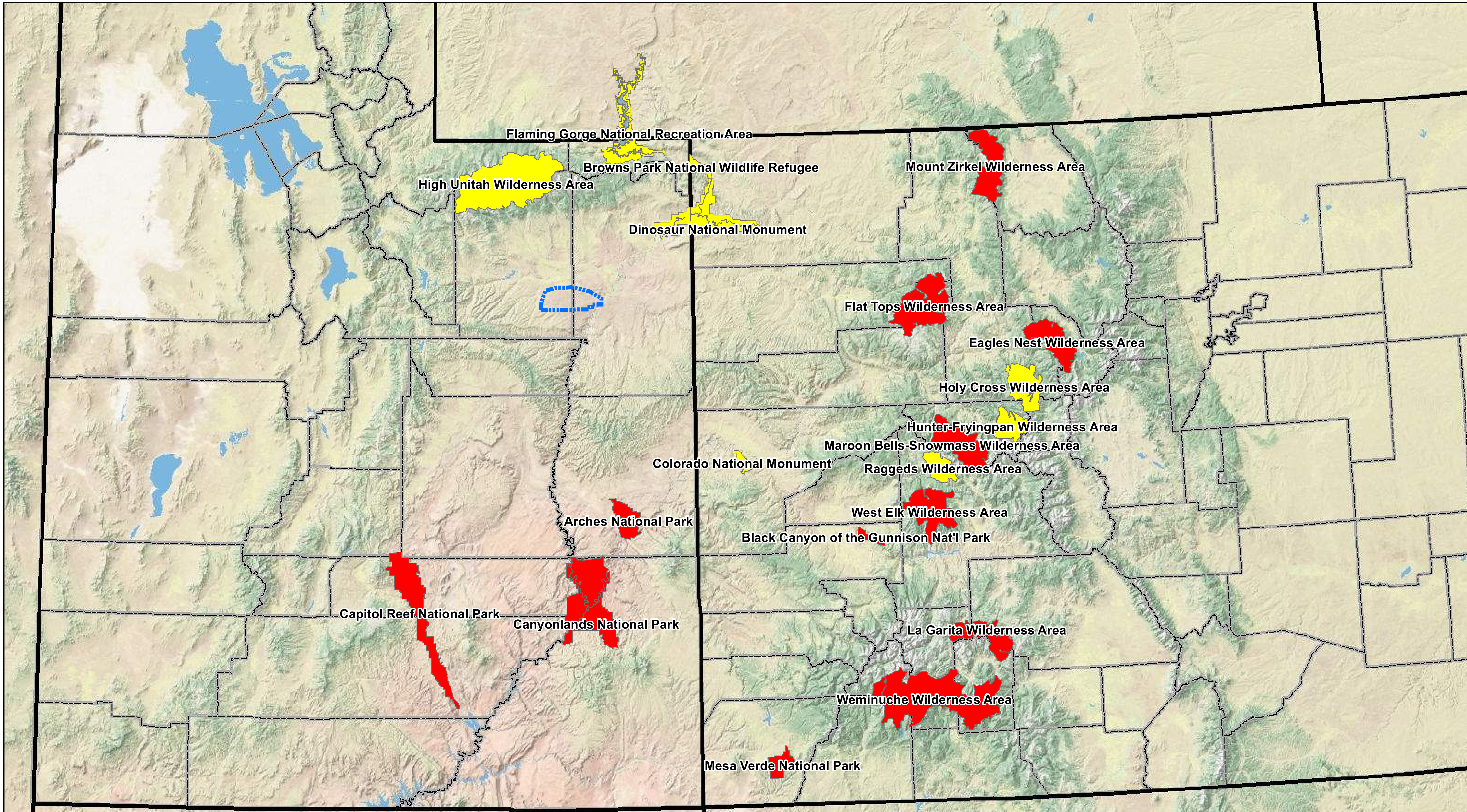
The No Action and Proposed Action emissions inventories demonstrated that although emissions from the Proposed Action will eventually exceed emissions that would occur under the No Action Alternative; for the first several years of the project, emissions associated with the No Action Alternative would be greater than any of the Action Alternatives (A, C, or D). Despite the fact that GNB assessed potential ozone formation for emissions including the Newfield Proposed Project and that No Action emissions would be greater than the Action Alternatives for the first few years of the Project; the fact that the Action Alternative emissions will eventually exceed the No Action emissions requires implementation of an Adaptive Management Strategy to mitigate the potential for adverse ozone formation. Details of the Adaptive Management Strategy are discussed in in Chapter 2, Section 2.2.11 of this EIS.

1.8 Summary

In summary, all of the evaluated potential air quality impacts of the Proposed Action and Alternatives are less than the evaluation criteria except for regional haze impacts in two sensitive Class II areas and one day in Arches National Park. The Federal Land Managers have not published thresholds for Class II areas.

No project specific ozone impact modeling was conducted due to the unavailability of a modeling assessment platform. When the Proposed Action Annual Development is compared to emissions that would occur under the No Action Alternative, it is found that annual development of the Proposed Action can continue through approximately early calendar year 2021 without causing a substantial increase in total ozone precursor emissions, or late 2019 for VOC emissions alone. This is due to the extensive ACEPMs and other emission reducing measures that Newfield will implement as future development in the MBPA proceeds under the Proposed Action or Alternatives C and D. Nevertheless, an Adaptive Management Strategy to mitigate potential ozone formation will be implemented under any of the Action Alternatives.

Section 2 describes the Proposed Action and Alternatives, Section 3 the pre-project background air quality, Section 4 the emissions, and Section 5 the impact assessment methodology. Sections 6, 7 and 8 describe the evaluation results. The Appendices contain hard copies of the emission inventories and electronic copies of the modeling input and output files.



Legend

- Class I Areas
- Class II Areas
- Project Boundary
- State Boundary
- County Boundary

0 12.5 25 50 Miles

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FILE NAME:	AirQuality_2.mxd

Monument Butte EIS

Newfield Production Company
Alternative A - Proposed Action Location

FIGURE
1-1

2 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

2.1 Alternative A – Proposed Action

The Proposed Action involves drilling and operations of up to 3,250 oil wells and 2,500 gas wells in the MBPA, including associated infrastructure. The Proposed Action includes the following primary components:

- Development of up to 750 Green River oil wells on 40-acre surface and downhole spacing drilled from new 2-acre well pads, all of which would be converted into water-flood injection wells within approximately 3 years;
- Development of up to 2,500 Green River oil wells on 20-acre downhole spacing that would be vertically, directionally, or horizontally drilled from existing and/or proposed 40-acre surface spaced Green River oil well pads, consistent with current State spacing requirements;
- Development of up to 2,500 vertical deep gas wells on 40-acre surface and downhole spacing drilled from new 3-acre well pads, which would be constructed adjacent to Green River oil well pads in order to reduce new surface disturbance and utilize existing utility infrastructure and access roads;
- Construction of approximately 243 miles of new 100-foot wide ROW that would be used for new road construction (40-foot width) and pipeline installation (60-foot width). Up to 70-foot wide expansion along approximately 363 miles of existing access road ROW that would be used for road upgrade (10-foot width) and pipeline installation (60-foot width);
- Construction of 20 new compressor stations for deep gas well development;
- Expansion of three (3) existing Green River oil well compressor stations and construction of one (1) new compressor station for gas associated with Green River oil well development;
- Construction of a 50 million standard cubic feet per day (MMscf/d) centralized gas processing plant;
- Construction of seven (7) new and expansion of six (6) existing water treatment and injection facilities for management and distribution and injection of produced water;
- Construction of up to 12 Gas Oil Separation Plants (GOSPs) for oil and produced water collection;
- Development of one (1) fresh water collector well for water-flood operations; and

- Construction of six (6) water pump stations.

Newfield currently operates approximately 3,395 oil and gas wells in the MBPA, and proposes to drill additional wells at an average rate of approximately 360 wells per year until the resource base is fully developed. Under this drilling scenario, construction, drilling, and completion of up to 5,750 wells would occur in approximately 16 years. The total number of wells drilled would depend largely on outside factors such as production success, engineering technology, reservoir characteristics, economic factors, commodity prices, rig availability, and lease stipulations. The anticipated life of an individual well is 20 to 30 years, and the anticipated time it would take for field abandonment and final reclamation is 5 years. Therefore, the anticipated life of project (LOP) under the Proposed Action would be from 41 to 51 years.

The Proposed Action and Alternatives include applicant committed environmental protection measures (ACEPMs). The ACEPMs relevant to reducing potential air quality impacts are summarized as follows:

General

- Newfield would use water or other BLM-approved dust suppressants as needed during drilling, completion, and high traffic production operations for dust abatement.
- Newfield employees would comply with posted speed limits on unpaved county roads used for access and would use safe vehicle speeds on other unpaved access roads. Newfield would instruct contractors to comply with posted speed limits.
- The use of carpooling would be encouraged to minimize vehicle traffic and related emissions and Newfield would implement a vehicle policy to minimize idling while also recognizing safety concerns.
- Newfield would conduct a pilot test to evaluate the feasibility for converting fleet vehicles to cleaner burning compressed natural gas (CNG) or liquefied natural gas (LNG) fuels. The results of the pilot test would be submitted to the AO.

Drilling / Completion Operations

- Newfield would use Tier II diesel drill rig engines or equivalent with the phase-in of Tier IV engines or equivalent emission reduction technology by 2018.
- Newfield would employ reduced emission completion practices including: using the recovered gas as fuel for another useful purpose when feasible; routing all saleable quality gas to a flow line as soon as practicable; and safely maximizing resource recovery and

minimizing potential VOC emissions from hydraulically fractured, high pressure gas well flowback operations (not including low pressure oil wells). If high pressure gas well flowback emissions cannot be routed to a flow line, they will be captured and routed to a completion combustion device, unless such device will result in a fire or explosion hazard.

Production Operations

- Newfield would utilize for new construction low or intermittent bleed pneumatic devices to minimize VOC emissions. High bleed devices may be allowed for critical safety and/or process purposes.
- High bleed pneumatic devices at existing Newfield facilities would be replaced/retrofitted with low or intermittent bleed devices when repair or replacement is warranted, and no later than 6 months after the ROD is signed. High bleed devices may be allowed to remain in service for critical safety and/or process purposes.
- Newfield would employ for new construction glycol dehydrator still vent emission controls with a control efficiency of 95 percent or greater.
- Newfield would conduct a study to evaluate the feasibility for the implementation of “low emission” glycol dehydrators. The results of this study would be submitted to the AO.
- Newfield would install emission controls with an efficiency of 95 percent on tanks that have been constructed, modified or re-constructed after August 23, 2011, with the potential to emit greater than 6 tons per year (tpy) VOC.
- Newfield would implement a telemetry monitoring system where feasible to provide for the effective management of production exceptions while reducing the number of vehicle trips and miles traveled.

Central Facilities

- Newfield would install electric motor driven compression where feasible. Where electrification is not feasible, Newfield would utilize lean-burn natural gas fired compressor engines or equivalent rich-burn engines with catalysts. Lean-burn engines would be fitted with oxidation catalysts to minimize carbon monoxide and VOC emissions.
- Newfield would maximize the use of central compression thereby reducing the need for smaller and less efficient (higher emission) well site compressor units.
- Newfield would periodically replace rod packing systems on reciprocating compressors and when feasible use dry seals on centrifugal compressors to minimize the loss of VOC.
- Newfield would employ for new construction glycol dehydrator still vent emission controls with a control efficiency of 95 percent or greater.

- Newfield would install for new construction emission controls with an efficiency of 95 percent or greater on stock tanks that have the potential to emit VOC greater than 6 tons per year (tpy).

GOSP Implementation

- Where feasible, Newfield would implement Green River oil gathering systems and construct GOSPs. With GOSP implementation, the majority of the stock tanks, produced water tanks and related tank heaters at affected existing well sites would be removed from service. New wells served by a GOSP would be constructed without tank batteries thereby eliminating tank battery and related tanker truck emissions.
- The GOSP facilities would be specifically designed to minimize the emission of VOC. Storage tank emissions would be captured and reused within the facility process or sold as product. Vapors from truck loading operations would be controlled by 95 percent.

Monitoring Programs

- Newfield would annually evaluate the deep gas gathering system to identify opportunities for pressure optimization resulting in reduced flash emissions from condensate storage tanks.
- Newfield would implement visual inspections of thief hatch seals and pressure relief valves on condensate tanks to ensure proper operation and minimize losses of VOCs. Inspections will be conducted at least annually during a routine maintenance visit. If for some reason monitoring does not occur within 12 months, the visual inspection will be conducted at the next scheduled maintenance visit.

Adaptive Management

- Newfield would implement an adaptive management program described in Chapter 2, Section 2.2.11 of this EIS that would evaluate project specific emissions on an annual basis and identify opportunities to further reduce emissions.

Cooperative Efforts and Outreach

- Newfield would encourage and lend technical support to scientific research efforts focused on improving the understanding of ozone formation chemistry within the Uinta Basin, emission inventory enhancements, source apportionment studies, ozone precursor transport studies, precursor sensitivity studies, and evaluations of cost effective control strategies.

- Newfield would incorporate ozone awareness and specific actions for reducing ozone precursor emissions into the current employee training program.

In addition to the ACEPMs, Newfield will implement BLM Control Measures as described in Chapter 2, Section 2.2.14.

2.2 Alternative B – No Action

Under the No Action Alternative, the proposed oil and gas infill development project on public land surface and/or federal mineral estates as described in the Proposed Action would not be implemented. However, proposed oil well development would likely continue on State and private lands within the Monument Butte Field, subject to the approval of UDOGM or the appropriate private land owner. Reasonable access across BLM-administered surface to proposed well pads and facilities on State and private lands could also occur under the No Action Alternative, as allowed by Federal regulations. Development, production, and maintenance activities for wells approved under the August 2005 Record of Decision (ROD) for the Castle Peak and Eight Mile Flat Oil and Gas Expansion EIS and approved Master Development Plans (MDPs) would also continue on BLM-administered lands. The No Action Alternative would result in an additional 788 oil and gas wells being drilled and placed into production in the MBPA. Further details related to emissions associated with the No Action Alternative are discussed in Section 4.

2.3 Alternative C – Field-Wide Electrification

This alternative was developed in response to air quality issues raised during the public and agency scoping process. The principal component of this alternative entails a phased field-wide electrification system that would be integrated in the MBPA over an estimated 7 year period. This alternative would incorporate the same construction and operation components for the Proposed Action, except that gas-driven motors would be converted to electric motors as field electrification is phased into the Project Area. The electrical energy would be supplied either from substations built by Newfield or from commercial power.

Under Alternative C, the same number (5,750) of oil and gas wells as the Proposed Action would be developed in the MBPA. Alternative C includes all of the Proposed Action components plus the following if the electrical power is provided by Newfield substations:

- Phased field-wide electrification consisting of construction of approximately 34 miles of overhead, cross-country 69kV transmission line, 156 miles of distribution lines, and construction of 11 substations;
- Installation of two 20 megawatt electric (MWe) gas turbine generators and one 10 MWe steam turbine for a combined generation of 50 MWe at each of the 11 substations (550 MWe throughout the MBPA);
- Replacement of all 3,250 pumpjack engines with electric motors;
- Replacement of all compressor engines with electric motors; and
- Removal of on-site gas-fueled electrical generators.

If commercial power provides the electrical energy, the gas turbine generators and steam turbine generators would not be built. The electrical substations would likely still be needed, however.

Under Alternative C, both the ACEPMS and the Adaptive Management Strategy of the Proposed Action (Alternative A) will also be implemented.

2.4 Alternative D – Resource Protection (Agency Preferred Alternative)

Alternative D, the Resource Protection Alternative, is the Agency Preferred Alternative. Alternative D was developed to respond to sensitive resource and land use issues in the Project Area expressed during scoping. For the MBPA, the primary objective of the Resource Protection Alternative is to meet the purpose and need for the Project while avoiding new surface disturbance within the Pariette ACEC, minimizing the amount of new surface disturbance within USFWS proposed Level 1 and 2 Core Conservation areas (for two federally-listed plant species: the Uinta Basin hookless cactus [Sclerocactus wetlandicus] and Pariette cactus [Sclerocactus brevispinus], and minimizing the amount of new surface disturbance in other portions of the MBPA (100-year floodplains and riparian habitats), and minimizing overall impacts through the use of directional drilling technology.

This alternative would incorporate the same construction and operation components as the Proposed Action and Alternative C, but with fewer well pad locations. Under Alternative D, at most 5,750 oil and gas wells would be developed on BLM, State, and private lands in the MBPA. Newfield proposes to drill the wells at an average rate of approximately 360 wells per year until the resource base is fully completed, requiring about 16 years for full development. (For purposes of this AQIA, the drilling rate was assumed to be 360 wells per year for 16 years; 3,250 of the wells would be oil and 2,500 of the wells would be deep gas.)

Alternative D includes the following primary components:

- Development of approximately 3,250 new Green River vertical oil wells to be drilled from a combination of new, small and large well pads;.
- Development of approximately 2,500 new deep gas wells that would be vertically or directionally drilled from a combination of new and existing, large well pads; Construction of up to 20 new compressor stations for deep gas well development;
- Expansion of three existing Green River oil well compressor stations and construction of one new compressor station for gas associated with Green River oil well development;
- Construction of up to one (1) 50 MMscf/d centralized Green River oil well gas processing plant;
- Construction of up to thirteen (13) gas driven water treatment and injection facilities for management and distribution and injection of produced water;
- Construction of up to twelve (12) GOSPs for oil and produced water collection;
- Development of one (1) fresh water collector well for water-flood operations; and
- Construction of six (6) water pump stations.

Under Alternative D, both the ACEPMS and the Adaptive Management Strategy of the Proposed Action (Alternative A) will also be implemented.

3 PRE-PROJECT AMBIENT AIR QUALITY AND STANDARDS

Potential impacts of the proposed project are compared to the National and State Ambient Air Quality Standards, Prevention of Significant Deterioration (PSD) increments, and thresholds of concern as described in the following paragraphs.

3.1 Ambient Air Quality Standards and PSD Increments

Utah and National Ambient Air Quality Standards (UAAQS and NAAQS) have been promulgated for the purpose of protecting human health and welfare with an adequate margin of safety. Pollutants for which standards have been determined include sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), particulate matter less than 10 microns in diameter (PM_{10}), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) and lead (Pb). In Utah, the State and National Ambient Air Quality standards are the same and are shown in Table 3-1.

The PSD program establishes allowable incremental increases in ambient concentrations of certain pollutants. All of the land areas of the US are currently classified as either Class I or Class II. Class I areas include many national parks and wilderness areas and some Native American lands. Areas not designated Class I are designated Class II. Class I areas and sensitive Class II areas of interest for the Proposed Project are discussed in Section 5. The PSD increments are shown in Table 3-1.

Throughout this impact analysis, all comparisons with PSD increments are intended as a point of reference only and do not represent a regulatory PSD increment consumption analysis. PSD increment consumption analyses are applied to large industrial sources during the permitting process, and are the responsibility of the State of Utah with USEPA oversight. The Proposed Project is not subject to the PSD program.

Table 3-1
National and State Ambient Air Quality Standards and PSD Increments

Pollutant	Averaging Period(s)	NAAQS [a]	PSD Class I Increment [a]	PSD Class II Increment [a]
CO	1-hour 8-hour	35 ppm (40,000 µg/m³) [b] 9 ppm (10,000 µg/m³) [b]	-- --	-- --
NO_2	1-hour Annual	100 ppb (188 µg/m³) [c] 0.053 ppm (100 µg/m³) [d]	-- 2.5 µg/m³	-- 25 µg/m³
PM_{10}	24-hour Annual	150 µg/m³ [e] -----	8 µg/m³ 4 µg/m³	30 µg/m³ 17 µg/m³
$PM_{2.5}$	24-hour Annual	35 µg/m³ [c] 12 µg/m³ [f]	2 µg/m³ 1 µg/m³	9 µg/m³ 4 µg/m³
O_3	8-hour	0.075 ppm [g]	--	--
SO_2	1-hour 3-hour 24-hour Annual	75 ppb (196 µg/m³) [h] 0.5 ppm (1,300 µg/m³) [b] ----- -----	-- 25 µg/m³ 5 µg/m³ 2 µg/m³	-- 512 µg/m³ 91 µg/m³ 20 µg/m³
Lead	Rolling 3 month	0.15 µg/m³ [i]	--	--

[a] Source: 40 CFR Part 50 and 51
[b] Not to be exceeded more than once per year.
[c] 98th percentile averaged over 3 years.
[d] Annual mean.
[e] Not to be exceeded more than once per year on average over 3 years.
[f] Annual mean, averaged over three years.
[g] Annual fourth-highest daily maximum 8-hour concentration averaged over 3 years.
[h] 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years.
[i] Not to be exceeded.

3.2 Pre-Project Background Ambient Air Quality

Table 3-2 presents the background, pre-project, ambient air quality in the MBPA for the criteria pollutants and averaging times for which a NAAQS has been established. Available data from the most recent 3 - 6 years are presented. The data in Table 3-2 comes from the Greater Natural Buttes FEIS (BLM 2012) and the USEPA Air Quality System Data Mart web site (USEPA, 2014). The data from Table 3-2 were used to select a single value for each NAAQS pollutant and averaging time to be used in the air quality impact assessment as the background pre-project values. The selected values and the rationale for the selection are presented in Table 3-3.

Table 3-2
Pre-Project Background Ambient Air Quality in the Uinta Basin

Criteria Pollutant	Average	Rank [a]	Year [b]	Value [c] (µg/m^3)	Criteria Pollutant	Average	Rank [a]	Year [b]	Value [c] (µg/m^3)	Station [d]
CO	1-hour	H2H	2007	4,350	CO	8-hour	H2H	2007	2,796	Grand Junction, CO
			2008	10,564				2008	2,641	
			2009	3,573				2009	2,175	
			2010	2,641				2010	1,709	
			2011	2,796				2011	1,709	
			2012	2,486				2012	1,554	
NO_2	1-hour	H8H	2011	58.2	NO_2	Annual	H	2010	7.3	Ouray, UT
			2012	48.8				2011	7.3	
			2013	86.4				2012	6.6	
NO_2	1-hour	H8H	2011	63.8	NO_2	Annual	H	2010	8.8	Redwash, UT
			2012	46.9				2011	8.7	
			2013	90.1				2012	7.7	
PM_{10}	24-hour	H2H	2004	19.0						Myton, UT [f]
			2005	20.0						
			2006	17.0						
			2012 [f]	48.0						
$PM_{2.5}$	24-hour	H8H	2010	18.6	$PM_{2.5}$	Annual	H	2010	7.1	Ouray
			2011	22.5				2011	7.2	
			2012	27.4				2012	7.9	
$PM_{2.5}$	24-hour	H8H	2010	16.0	$PM_{2.5}$	Annual	H	2010	5.6	Redwash
			2011	17.7				2011	6.0	
			2012	15.9				2012	5.9	
O_3	8-hour	H4H	2010	117 ppb						Ouray
			2011	116 ppb						
			2012	70 ppb						
			2013	133 ppb						
	8-hour	H4H	2010	98 ppb						Redwash
			2011	100 ppb						
			2012	67 ppb						
			2013	112 ppb						
SO_2	1-hour	H4H	2007	21.7 [e]	SO_2	3-hour	H2H	2007	16.0 [e]	Sweet-water, WY [g]
			2008	19.7 [e]				2008	16.7 [e]	
			2009	19.0 [e]				2009	10.1 [e]	
			2012 [g]	2.6				2012 [g]	0.9	

[a] Rank: H2H = High, 2nd high for NAAQS not to be exceeded more than once per year. H8H = 98th percentile. H4H = 99th percentile. H = maximum value for period.

[b] Calendar year.

[c] Data are from the USEPA Air Quality System Data Mart web site (USEPA 2014) except as noted. Conversion from monitored ppm/ppb to ug/m^3 made at 1 atmosphere and 25 degrees C.

[d] Monitor location is the monitor closest to the Proposed Project area for which data are available in the USEPA AQS database. Grand Junction is Station ID 08-077-0018, Ouray is Station ID 49-047-2003, Redwash is Station ID 49047-2002, Myton is Station ID 49-013-7011, Sweetwater is Station ID 56-037-0200.

[e] Data reported in the Greater Natural Buttes Final Environmental Impact Statement (GNB FEIS) (BLM 2012).

[f] The Myton PM_{10} monitor collected data only through 2006. There is a new monitor in Roosevelt, UT located approximately 35 miles west-northwest of the Proposed Project area, Station ID 49-013-0002, which has PM_{10} data available from January 1, 2012 through August 30, 2012, and only those data are reported for 2012.

[g] The 2007 through 2009 data are from the Wamsutter Monitoring Station in Sweetwater County (Station ID 56-037-0200 as reported in the GNB FEIS (BLM 2012). There is a new monitor in Roosevelt, UT located approximately 35 miles west-northwest of the Proposed Project area, Station ID 49-013-0002, which has SO_2 data available from May 1, through June 30, 2012, and only those data are reported for 2012.

Table 3-3
Pre-Project Background Ambient Air Quality Values Used in AQIA

Criteria Pollutant	Average	Value ($\mu g/m^3$)	Rationale for Selection
CO	1-hour	2,641	Average of the most recent three years (2010 – 2012) of second-high values from the Grand Junction, CO monitor.
	8-hour	1,657	
NO_2	1-hour	65.7	Average of the most recent three years available (2011 - 2013) of eighth-high values (98th percentile) for both the Ouray and Redwash monitors.
	Annual	8.8	Highest value of the most recent three years available data (2010 - 2012) for both the Ouray and Redwash monitors. Note that unlike the 1-hour NO_2 data, 2013 annual data was not available.
O_3	8-hour	208 (106 ppb)	Average of the most recent three full years available (2011 -2013) of fourth-high values forthe Ouray monitor. The Ouray monitor was chosen as it was higher than the Redwash monitor.
PM_{10}	24-hour	18.7	Average of the most recent three years available (2004 – 2006) of the Myton monitor. The Roosevelt monitor is not used as that monitor is located in a disturbed area in the City.
$PM_{2.5}$	24-hour	19.7	Average of the most recent three years available (2010 -2012) of eighth-high values (98th percentile) for both the Ouray and Redwash monitors. 2013 data was not available.
	Annual	6.6	Average of the most recent three years available (2010 - 2012) for both the Ouray and Redwash monitors. 2013 data was not available.
SO_2	1-hour	20.1	Average of the most recent three years available (2007 – 2009) of fourth-high (99th percentile) values from the Sweetwater monitor. Although the Roosevelt monitor is more representative of the Uinta Basin, the data are not complete (only two months) and is not used.
	3-hour	14.3	Average of the most recent three years available (2007 – 2009) of second-high values from the Sweetwater monitor. Although the Roosevelt monitor is more representative of the Uinta Basin, the data are not complete (only two months) and is not used.

3.3 Acute and Chronic Hazardous Air Pollutants Exposure Thresholds

Hazardous Air Pollutants (HAPs) predicted to be released in meaningful quantities associated with the Proposed Action project include benzene, toluene, xylene, formaldehyde, and acrolein. Hydrogen sulfide (H_2S) is not expected to constitute a meaningful portion of the gas stream and therefore was not assessed. Since there are no applicable federal ambient air quality standards for HAPs, Reference Concentrations (RfC) for chronic inhalation exposure and Reference Exposure Levels (REL) for acute inhalation exposures are used as evaluation criteria. The RfCs represent an estimate of the continuous (i.e. annual average) inhalation exposure rate to the human population (including sensitive subgroups such as children and the elderly) without adverse health effects. The RELs represent the acute (i.e. one-hour average) concentration at or below which no adverse health effects are expected. Both the RfC and REL guideline values are for non-cancer effects.

Values for the RfCs and RELs are provided in Table 3-4. The values in Table 3-4 are from the USEPA Air Toxics Database, Tables 1 and 2 (USEPA 2011a and USEPA 2012), except for acrolein. There is a wide range of RfCs published for acrolein, ranging from 0.02 µg/m^3 (USEPA 2012) to 250 µg/m^3 (OSHA 2013). Acrolein in air is rapidly removed by reacting with photochemically generated hydroxyl radicals, and the primary environmental exposure to acrolein comes from smoking and heating of fats and vegetable oils at high temperatures (ATSDR 2013). Acrolein is also present naturally in the body (ATSDR 2013). The USEPA RfC of 0.02 µg/m^3 was extrapolated from a Lowest Observed Adverse Effect Level (LOAEL) of 900 µg/m^3 (USEPA 2009) and the USEPA indicated that there is at least an order of magnitude uncertainty in the extrapolation. The California Office of Environmental Health Hazard Assessment (OEHHA) has thoroughly reviewed the toxicity of acrolein and published an RfC of 0.35 µg/m^3 (OEHHA 2013). Since the OEHHA value is near the lower end of the range of published RfCs and is not as uncertain as the USEPA value, the OEHHA value is used.

Table 3-4
HAP Reference Exposure Levels and Reference Concentrations

Hazardous Air Pollutant (HAP)	**Reference Exposure Level [REL 1-hr Average]** (µg/m^3)	**Reference Concentration [RfC Annual Average]** (µg/m^3)
Benzene	1,300	30
Toluene	37,000	5,000
Xylenes	22,000	100
Formaldehyde	55	9.8
Acrolein	2.5	0.35

In addition to the RELs and RfCs, the State of Utah has adopted Toxic Screening Levels (TSLs) which are used during the air permitting process to assist in the evaluation of hazardous air pollutants released into the atmosphere (Utah Department of Environmental Quality- Division of Air Quality, UDAQ 2011). The TSLs are derived from Threshold Limit Values (TLVs) published in the American Conference of Governmental Industrial Hygienists (ACGIH) – "Threshold Limit Values for Chemical Substances and Physical Agents". These levels are not standards that must be met, but screening thresholds which if exceeded, would suggest that additional information is needed to evaluate potential health and environmental impacts. The TSLs are compared against modeled concentrations for averaging periods of 1-hour (short-term) and 24-hour (chronic).

Table 3-5 lists the TSLs for each applicable HAP. The TSLs in Table 3-5 are published by the Utah Department of Environmental Quality – Utah Division of Air Quality (UDAQ 2012).

Table 3-5
Utah Toxic Screening Levels (TSLs)

Pollutant and Averaging Time	Toxic Screening Levels ($\mu g/m^3$)
Benzene (24-hour)	18
Toluene (24-hour)	2,512
Xylenes (24-hour)	14,473
Formaldehyde (1-hour)	37
Acrolein (1-hour)	23

3.4 Incremental Cancer Risk

To assess long-term exposure from carcinogenic HAP emissions, traditional risk assessment methods are applied and the risk for the maximally exposed individual (MEI) and most likely exposure (MLE) are compared to the generally acceptable risk range of one additional cancer per one million exposed persons (1×10^{-6}) to one additional cancer per ten thousand exposed persons (1×10^{-4}) or 100 in a million (USEPA 1993). For the MEI risk, it is assumed that a person is exposed continuously (24 hours per day, 365 days per year) for the life of project. For the MLE risk, an adjustment was made for the amount of time a family stays at a residence (nine years) and for the portion of time spent away from the home (64 percent of the day) (USEPA 1997). It is further assumed that households are exposed to one-quarter of the maximum concentration the remaining (36 percent) of the time. Exposure adjustment factors of 0.571 for the MEI (40/70) and 0.095 for the MLE [(9/70)*((0.64*1) + (0.36*0.25))] are applied to the estimated cancer risk to account for the actual time that an individual could be exposed during a 70-year lifetime.

In addition to the exposure assumption, unit risk factors (URFs) are used to assess potential carcinogenic risk. The URFs are multiplied times the annual average concentration of the potentially carcinogenic HAP and the exposure adjustment factor to calculate the potential cancer risk. URFs are derived for a continuous 70-year exposure, and that is why the exposure adjustment factors must be used. URFs are based on the USEPA guidelines on carcinogen risk assessment that assume cancer risks exist at any dose, the so-called zero threshold assumption (USEPA 1986). More recent data show that there are some exceptions to this zero threshold assumption and thus URFs are over-stated; however it is still the default assumption (USEPA 2005). Therefore the URFs provide an upper bound carcinogenic risk.

The chronic inhalation cancer risk factors for benzene and formaldehyde are presented in Table 3-6.

Table 3-6
Carcinogenic Unit Risk Factors

Hazardous Air Pollutant	Carcinogenic Unit Risk Factor [Annual Inhalation Exposure] ($1/\mu g/m^3$)
Formaldehyde [a]	1.3×10^{-5}
Benzene [a]	2.2×10^{-6} to 7.8×10^{-6}

[a] USEPA Integrated Risk Information System (IRIS) database (USEPA 2008). A range of risk factors is published for benzene.

4 EMISSIONS

Five sets of emissions were calculated as part of the AQIA: Proposed Action Ultimate Development (Alternative A), Proposed Action Annual Development (Alternative A), No Action Alternative (Alternative B), Field-Wide Electrification (Alternative C), and Resource Protection (Alternative D).

Emissions occur during two primary phases of the Proposed Action and Alternatives: the development phase and the operations phase. The development phase includes emissions from the following activities:

- Construction
- Drilling
- Completion
- Interim Reclamation
- Wind Erosion

The operations or production phase includes emissions from:

- Pump unit engines
- Production heaters
- Well-site tanks
- Pneumatic controllers
- Fugitive emissions of volatile organic compounds
- Well-site truck loading emissions
- Well-site flares
- Operations vehicle fugitive dust and tailpipe emissions

In addition to the development and the operations phases, infrastructure must be built to serve the operating wells. Infrastructure emissions include emissions from the following activities:

- Water treatment facility oil tanks, fugitive emissions of volatile organic compounds and emissions from gas generators
- Gas Oil Separation Plants (GOSPs), including truck loading emissions

- Compressor station emissions, including engines, tanks, dehydrators, flares and fugitives
- Gas processing plant

In the following subsections, emissions from these activities are summarized by the development, production, and infrastructure phases. Details for emissions from the activities within these phases and details for how the emissions were calculated, including assumptions, are shown in the Appendices as noted. In the summary tables presented below, only the criteria pollutants, greenhouse gas pollutants (including global warming potential, GWP), and key hazardous air pollutants for which evaluation criteria have been established as discussed in Section 3 (i.e., benzene, toluene, xylene, formaldehyde, acrolein) and total HAPs are reported. However, all of the HAP emissions are shown in the referenced appendices. The emission estimates account for the ACEPMs and other environmental protection measures that Newfield will implement. All of the emissions are reported in short tons (2,000 pounds per ton). GWP is calculated with a value of 1.0 for carbon dioxide, 21 for methane, and 310 for nitrous oxide.

4.1 Alternative A: Proposed Action Ultimate Development

The Proposed Action will result in up to 5,750 oil and gas wells (3,250 oil, 2,500 gas) being developed and operated along with the required infrastructure as described in Section 2. In order to assess the ambient air quality impacts of the Proposed Action, a maximum emissions year calculation was prepared, assuming normal well drilling frequency (approximately 360 wells per year), and full production from all 5,750 wells and operation of the entire Proposed Action infrastructure. This emissions scenario is termed the Proposed Action Ultimate Development.

Table 4-1 summarizes the emissions for the Proposed Action Ultimate Development. Appendix A shows how the emissions were calculated, including the detailed calculation formulas and assumptions. Appendix A-1 shows emissions for the oil wells; Appendix A-2 shows emissions for the gas wells. The emission inventory for the Proposed Action includes the benefit of the ACEPMs and regulatory requirements under the recently promulgated (August 16, 2012) New Source Performance Standard for oil and gas operations (Oil and Gas NSPS) published as 40 CFR 60 Subpart OOOO. The emissions do not include the benefit of emission reductions that may be required under the State of Utah permitting guidance and State or Federal Implementation Plans (SIP or FIP) for the Uinta Basin, tribal New Source Review (NSR) programs that will be promulgated in the near future (late 2013 or 2014), nor additional mitigation that may be required under the Adaptive Management Strategy to mitigate potential adverse ozone formation. These programs will likely require additional emission reduction measures for the Proposed Action.

Table 4-1
Proposed Action Ultimate Development Emissions

Pollutant	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Total Emissions (tpy)
Criteria Pollutants									
	Oil Wells				Gas Wells				Project Total
NO_x	129.6	1,809.7	981.0	2,920.2	668.6	511.1	1,590.2	2,769.9	5,690.1
CO	106.0	2,290.7	1,782.8	4,179.6	594.3	523.1	3,226.8	4,344.2	8,523.8
VOC	12.1	3,929.0	1,109.2	5,050.3	35.9	3,795.8	1,479.0	5,310.6	10,360.9
SO_2	0.2	3.9	2.8	6.9	1.2	2.9	3.4	7.5	14.4
PM_{10}	423.3	570.3	393.2	1,386.7	1,145.1	283.0	88.8	1,516.9	2,903.6
$PM_{2.5}$	46.0	224.1	95.6	365.8	128.4	61.8	60.9	251.2	617.0
Hazardous Air Pollutants									
	Oil Wells				Gas Wells				Project Total
Benzene	0.084	16.25	5.61	21.95	0.52	26.15	13.95	40.62	62.57
Toluene	0.031	12.01	3.93	15.98	0.19	48.84	10.89	59.92	75.90
Xylene	0.020	3.63	1.08	4.73	0.13	37.30	2.51	39.94	44.67
Formal-dehyde	0.0080	182.68	49.38	232.07	0.053	0.36	148.50	148.92	380.99
Acrolein	0.00080	25.71	5.40	31.12	0.0053	---	14.47	14.48	45.60
Total HAPs	0.26	446.77	107.16	554.19	1.05	211.21	238.28	450.54	1,004.73
Greenhouse Gases									
	Oil Wells				Gas Wells				Project Total
CO_2	18,776	780,830	597,890	1,397,495	116,923	602,127	714,145	1,433,195	2,830,690
CH_4	18.81	3,816	668	4,502	4.60	7,152	928	8,085	12,587
N_2O	0.15	1.47	1.11	2.73	0.93	1.13	1.34	3.40	6.13
GWP	19,218	861,421	612,256	1,492,895	117,308	752,679	734,054	1,604,041	3,096,936

4.2 Alternative A: Proposed Action Annual Development

It will require approximately 16 years for the Proposed Action Development to be completed. Accordingly, not only was an assessment made for the Proposed Action Ultimate Development, emissions were assessed on an annual basis for development after December 31, 2011 through December 31, 2022. This yields a ten-year view of how emissions will change on an annual basis. For the annual development assessment, only NO_x and VOC emissions were evaluated because the purpose of the Proposed Action Annual Development analysis was to determine when or if emissions of ozone precursors in the MBPA would substantially increase as the result of the Proposed Action compared to emissions of ozone precursors in the MBPA that would otherwise occur under the No Action Alternative.

Table 4-2 shows the annual development emission increases in the MBPA. The details for these emission calculations are shown in Appendix B. The emissions shown include the benefit of the Oil and Gas NSPS and the ACEPMs but do not include emission reductions that may be required under a SIP, FIP, or NSR programs that may be promulgated in the near future nor mitigation that may be required under the Adaptive Management Strategy to mitigate potential adverse ozone formation.

Table 4-2
Proposed Action Annual Development Emission Increases

1	2	3	4	5	6	7	8
Calendar Year	**Cumulative Net Change in NO_x from December 31, 2011** (tpy)	**Cumulative Net Change in VOC from December 31, 2011** (tpy)	**Cumulative Net Change in NO_x plus VOC from December 31, 2011** (tpy) (2+3)	**Cumulative Number of Oil Wells Added**	**Cumulative Number of Gas Wells Added**	**Cumulative Wells Shut In or Converted to Water Injection**	**Cumulative Net Change in Number of Oil and Gas Producing Wells from December 31, 2011** (5+6-7)
2012	-53	25	-28	187	0	200	-13
2013	-172	-603	-775	363	0	400	-37
2014	-311	-684	-995	559	0	600	-41
2015	-387	-545	-932	794	0	800	-6
2016	-320	-99	-415	1,038	0	950	88
2017	-149	580	431	1,281	0	950	331
2018	-16	1,383	1,367	1,524	0	950	574
2019	194	2,213	2,407	1,767	12	950	829
2020	378	3,086	3,464	2,010	24	950	1,084
2021	561	3,959	4,520	2,253	36	950	1,339
2022	745	4,833	5,578	2,496	48	950	1,594

4.3 Alternative B: No Action Alternative

Under the No Action Alternative, oil and gas development and production in the MBPA will continue to occur on state, private, and federal lands. An analysis date of December 31, 2012 was chosen to forecast how many additional wells would be developed in the MBPA. Such development includes 218 additional oil wells yet to be drilled and placed into production in the Castle Peak and Eight Mile Flat Oil and Gas Expansion (Castle Peak) project area, 23 additional oil wells to be developed under approved Master Development Plans (MDP) Numbers 17 through 22 and 25 that are outside the Castle Peak project area, and an additional 547 oil and gas wells (209 gas, 338 oil) to be developed on state and private land; for a total of 788 oil and gas wells to be developed after December 31, 2012.

The number of wells yet to be developed in the Castle Peak project area is based on the following:

- The EIS analyzed a total of 973 wells, but assumed that 150 would be converted into water injection wells, for a net of 823 producing oil wells.
- The August 2005 Record of Decision (ROD) only authorized a net total of 778 producing oil wells.
- As of December 31, 2011, Newfield reported that there were 560 producing oil wells in the Castle Peak project area (Newfield 2012).
- Newfield reported that in the entire MBPA (which is a much greater area than the Castle Peak project area), in calendar year 2012, there would be a net reduction of approximately 17 wells (net of new wells and wells shut-in or converted to water injection). This is out of a total of several thousand wells in the MBPA.
- Therefore, it was assumed that the number of wells in the Castle Peak project area would remain unchanged in Calendar year 2012.
- Accordingly, there is a total of a net of 218 oil wells to be developed in the Castle Peak project area (778 authorized by the ROD minus 560 developed as of December 31, 2012).

The number of wells to be developed under the MDPs was calculated from the fact that MDPs 17 through 22 and 25 authorized a total of 146 wells to be developed after December 31, 2012, but all but 23 of those wells are in the Castle Peak project area and are included in those numbers. Thus only 23 additional wells will be developed under the MDPs.

Table 4-3 shows the emissions that could occur under the No Action Alternative and details for how the emissions were calculated are in Appendix C.

Table 4-3
No Action Alternative Emissions

Pollutant	Well Development (tpy)	Well Production (tpy)	Infrastructure (tpy)	Total Project Emissions (tpy)
Criteria Pollutants				
NO_x	931.2	661.4	224.7	1,817.3
CO	498.7	558.1	440.5	1,497.4
VOC	178.1	1,707.2	231.6	2,116.9
SO_2	1.0	1.3	0.5	2.8
PM_{10}	598.7	169.6	41.8	810.1
$PM_{2.5}$	89.6	53.4	13.9	157.0
Hazardous Air Pollutants				
Benzene	0.43	11.16	2.17	13.75
Toluene	0.16	26.29	1.60	28.04
Xylene	0.10	42.79	0.37	43.26
Formaldehyde	0.043	32.89	16.87	49.80
Acrolein	0.0043	4.62	1.70	6.33
Total HAPs	0.98	196.07	30.55	227.61
Greenhouse Gases				
CO_2	94,746	249,841	117,217	461,805
CH_4	27.21	1,503	156	1,686
N_2O	0.76	0.47	0.22	1.45
GWP	95,553	281,549	120,563	497,665

The emissions shown for the No Action Alternative do not include the benefit of the ACEPMs that Newfield will implement associated with the Proposed Action Alternative nor potential emission reductions under the Adaptive Management Strategy to mitigate potential adverse ozone formation because those measures will not be implemented if the No Action Alternative is selected. The estimates do include the benefit of the Oil and Gas NSPS as that regulation is applicable to future development. However, one of the main benefits of the NSPS is control on storage tanks with the potential to emit greater than 6 tons per year. Under the No Action Alternative, in the MBPA, if none of the ACEPMs contemplated under the Proposed Action are implemented, the storage tanks would have emissions less than the 6 tpy threshold and thus no controls would be applied. As in the case of the Proposed Action, the emission estimates shown in Table 4-3 do not include benefits from future SIP, FIP, and NSR programs that may be implemented in the region in the near future.

4.4 Alternative C: Field-Wide Electrification

In Alternative C, Newfield would implement field-wide electrification which would be phased in over an approximate 7-year period. The electrification would result in replacing natural gas fired pumpjack engines, compressor engines, and generators with electric motors. Emission estimates for the Proposed Action (i.e., 5,750 wells) when Alternative C has been completely implemented are shown in Table 4-4, with details shown in Appendix D. The infrastructure emissions in Table 4-4 include the 550 MWe of electrical generation that Newfield proposed to build under Alternative C. If commercial electrical energy is used, the emissions will decrease to the values shown in Table 4-5. As is the case for the Proposed Action, the emissions for Alternative C include the benefit of ACEPMs and the Oil and Gas NSPS, but do not include emission reductions that may be required under a SIP, FIP, or NSR programs that may be promulgated in the near future nor mitigation that may be required under the Adaptive Management Strategy to mitigate potential adverse ozone formation.

4.5 Alternative D: Resource Protection (Agency Preferred Alternative)

In Alternative D, at most 5,750 oil and gas wells would be developed in the MBPA. For purposes of analysis, it was assumed that 3,250 of the wells would be oil wells and 2,500 would be deep gas wells. Drilling and development would still occur at an average rate of 360 wells per year until the resource base is fully completed, approximately 16 years. Emission estimates for Alternative D are shown in Table 4-6, with details shown in Appendix E. Appendix E-1 shows the oil well emissions and E-2 the gas well emissions. As is the case for the Proposed Action, the emissions for Alternative D include the benefit of ACEPMs and the Oil and Gas NSPS, but do not include emission reductions that may be required under a SIP, FIP, or NSR programs that may be promulgated in the near future nor mitigation that may be required under the Adaptive Management Strategy to mitigate potential adverse ozone formation.

Table 4-4
Development Emissions Under Alternative C Field-Wide Electrification and Self-Generated Electrical Energy

Pollutant	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Total Emissions (tpy)
Criteria Pollutants									
	Oil Wells				Gas Wells				Project Total
NO_x	129.6	344.6	250.1	724.3	668.6	511.1	90.8	1,270.5	1,994.8
CO	106.0	290.9	269.2	666.1	594.3	523.1	165.9	1,283.2	1,949.3
VOC	12.1	3,532.4	580.8	4,125.3	35.9	3,795.8	409.2	4,240.9	8,366.2
SO_2	0.2	2.0	2.0	4.1	1.2	2.9	1.2	5.3	9.4
PM_{10}	423.3	410.6	376.7	1,210.6	1,145.1	283.0	70.3	1,498.4	2,709.0
$PM_{2.5}$	46.0	64.4	79.1	189.6	128.4	61.8	42.4	232.7	422.3
Hazardous Air Pollutants									
	Oil Wells				Gas Wells				Project Total
Benzene	0.084	9.84	3.92	13.84	0.519	26.15	12.76	39.43	53.27
Toluene	0.031	8.83	3.91	12.78	0.188	48.84	10.63	59.66	72.44
Xylene	0.020	2.74	1.16	3.92	0.1290	37.30	2.44	39.86	43.78
Formal-dehyde	0.0080	0.25	4.21	4.47	0.0527	0.36	4.91	5.32	9.79
Acrolein	0.00080	---	0.037	0.038	0.00527	---	0.044	0.049	0.087
Total HAPs	0.26	183.91	41.53	225.69	1.05	211.21	42.23	254.48	480.17
Greenhouse Gases									
	Oil Wells				Gas Wells				Project Total
CO_2	18,776	394,514	1,018,246	1,431,536	116,923	602,127	983,856	1,702,905	3,134,441
CH_4	18.81	3,809	665	4,492	4.60	7,152	933	8,090	12,582
N_2O	0.15	0.74	1.90	2.80	0.93	1.13	1.85	3.91	6.71
GWP	19,218	474,727	1,032,792	1,526,737	117,308	752,679	1,004,029	1,874,015	3,400,752

Table 4-5
Development Emissions Under Alternative C Field-Wide Electrification with Commercial Electrical Energy

Pollutant	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Total Emissions (tpy)
Criteria Pollutants									
	Oil Wells				Gas Wells				Project Total
NO_x	129.6	344.6	202.5	676.7	668.6	511.1	33.7	1,213.3	1,890.0
CO	106.0	290.9	225.8	622.6	594.3	523.1	113.7	1,231.1	1,853.7
VOC	12.1	3,532.4	564.2	4,108.7	35.9	3,795.8	389.4	4,221.1	8,329.8
SO_2	0.2	2.0	1.0	3.2	1.2	2.9	0.1	4.2	7.4
PM_{10}	423.3	410.6	344.8	1,178.7	1,145.1	283.0	32.1	1,460.2	2,638.9
$PM_{2.5}$	46.0	64.4	47.3	157.8	128.4	61.8	4.2	194.5	352.3
Hazardous Air Pollutants									
	Oil Wells				Gas Wells				Project Total
Benzene	0.084	9.84	3.85	13.77	0.519	26.15	12.68	39.35	53.12
Toluene	0.031	8.83	3.17	12.03	0.188	48.84	9.74	58.76	70.79
Xylene	0.020	2.74	0.79	3.55	0.1290	37.30	1.99	39.42	42.97
Formal-dehyde	0.0080	0.25	0.13	0.38	0.0527	0.36	0.01	0.43	0.81
Acrolein	0.00080	---	0.000	0.001	0.00527	---	0.000	0.005	0.006
Total HAPs	0.26	183.91	35.62	219.79	1.05	211.21	35.14	247.39	467.18
Greenhouse Gases									
	Oil Wells				Gas Wells				Project Total
CO_2	18,776	394,514	242,780	656,070	116,923	602,127	53,296	772,345	1,428,415
CH_4	18.81	3,809	650	4,477	4.60	7,152	916	8,073	12,550
N_2O	0.15	0.74	0.44	1.33	0.93	1.13	0.09	2.16	3.49
GWP	19,218	474,727	256,565	750,510	117,308	752,679	72,556	942,543	1,693,053

Table 4-6
Development Emissions Under Alternative D Resource Protection

Pollutant	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Well Develop-ment (tpy)	Well Product-ion (tpy)	Infra-structure (tpy)	Total Emissions (tpy)	Total Emissions (tpy)
Criteria Pollutants									
	Oil Wells				Gas Wells				Project Total
NO_x	140.0	1,765.7	981.0	2,886.7	647.4	511.1	1,590.2	2,748.7	5,635.4
CO	109.3	2,266.8	1,782.8	4,158.8	586.3	523.1	3,226.8	4,336.2	8,495.0
VOC	13.0	2,321.5	1,109.2	3,443.7	34.1	3,795.8	1,479.0	5,308.8	8,752.6
SO_2	0.2	3.6	2.8	6.7	1.2	2.9	3.4	7.5	14.2
PM_{10}	429.7	566.7	393.2	1,389.7	1,117.0	283.0	88.8	1,488.8	2,878.5
$PM_{2.5}$	48.1	220.5	95.6	364.3	122.7	61.8	60.9	245.5	609.8
Hazardous Air Pollutants									
	Oil Wells				Gas Wells				Project Total
Benzene	0.084	11.15	5.61	16.84	0.52	26.15	13.95	40.62	57.46
Toluene	0.031	7.30	3.93	11.26	0.19	48.84	10.89	59.92	71.18
Xylene	0.020	2.12	1.08	3.22	0.13	37.30	2.51	39.94	43.16
Formal-dehyde	0.0080	182.65	49.38	232.03	0.053	0.36	148.50	148.92	380.95
Acrolein	0.00080	25.71	5.40	31.12	0.0053	---	14.47	14.48	45.60
Total HAPs	0.26	353.99	107.16	461.42	1.05	211.21	238.28	450.54	911.96
Greenhouse Gases									
	Oil Wells				Gas Wells				Project Total
CO_2	18,986	730,353	597,890	1,347,228	116,376	602,127	714,145	1,432,648	2,779,876
CH_4	18.81	3,447	668	4,133.4	4.59	7,152	928	8,085	12,218
N_2O	0.154	1.37	1.11	2.63	0.930	1.13	1.34	3.40	6.03
GWP	19428	803,161	612,256	1,434,846	116,760	752,679	734,054	1,603,493	3,038,339

5 IMPACT ASSESSMENT METHODOLOGY

Three different air quality impact assessments were conducted: Substantial Increase in Emissions Analysis, Near Field AQIA, and Far Field AQIA.

5.1 Substantial Increase in Emissions Analysis

In order to determine if implementation of the Proposed Action will result in a substantial increase in ozone precursor emissions, annual development emission increases in the MBPA for the Proposed Action were compared to emissions that would occur under the No Action Alternative in the MBPA. This analysis is discussed in Section 6 of this AQTSD.

5.2 Near Field AQIA

5.2.1 Dispersion Modeling

A dispersion model impact assessment was conducted to analyze the potential ambient air quality impacts of the Ultimate Proposed Action and Alternatives within 50 kilometers (km) of the project area, termed near field impacts. In order to conduct this analysis, the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) version 12345, promulgated through the USEPA Guideline on Air Quality Models, was used as the primary dispersion model for assessing near-field impacts (40 CFR Part 51, Appendix W). The AERMOD system contains three primary components: AERMOD (dispersion model with prime building downwash algorithms), AERMAP (terrain preprocessor), and AERMET (meteorological preprocessor). A special feature of AERMOD includes the capability to represent boundary layer meteorology and dynamics. The USEPA Guideline on Air Quality Models (40 CFR Part 51, Appendix W) specifies that impacts calculated with steady-state Gaussian plume models (AERMOD) are recommended at distances up to 50 km from the origin of the emission source.

The AERMET system utilizes both surface and upper air measurements in order to estimate profiles of wind, turbulence, and temperature in the planetary boundary layer. Minimum meteorological data requirements in the surface and upper air data files for successful execution of AERMET include horizontal wind speed, horizontal wind direction, ambient temperature, cloud cover, and a morning upper air sounding. The recent version of the model, however, has incorporated the Bulk Richardson Number scheme which removes the model dependence on cloud cover if Solar Radiation and Temperature Change with Height (SRDT) data are available. This is especially important in areas where cloud cover data are unavailable or considered to be non-representative. After entering the surface and upper air data into AERMET, the surface characteristics that pertain to the meteorological data are required, including; Albedo, Bowen Ratio and Surface Roughness.

Another requirement for model performance is representative meteorological data of the conditions affecting the transport and dispersion of pollutants within the modeling domain. Generally, this means that the surface characteristics surrounding the meteorological monitoring site should be similar to those within the modeling domain. While a degree of similarity may correlate with proximity of the monitoring site to the project site, meteorological data measured at more distant sites may be considered representative as long as it adequately represents the meteorology and surface characteristics of the modeling domain.

In consideration of these limitations, this analysis utilized five recent calendar years of surface meteorological data from Vernal, Utah. The data were supplied by the Utah Department of Environmental Quality – Division of Air Quality (UDAQ) and consist of surface measurements collected in Vernal, Utah for the years 2005-2009 combined with upper air data recorded in Grand Junction, Colorado for the same years.

The data were created by UDAQ by using the AERMET processing program which utilized the surface and upper air data to produce two types of finished data files for each meteorological year for use by AERMOD; surface scalar parameters and vertical profiles. A profile base elevation of 1,608 m (5,276 ft.) was used with the meteorological data for the execution of AERMOD.

The wind rose for the processed meteorological data is shown on Figure 5-1 (all figures for Section 5 are located at the end of the Section).

Different emissions source configurations were used to evaluate the maximum potential near field impacts of the Proposed Action and Alternatives: one set for PM_{10} and $PM_{2.5}$ emissions and another set for NO_x, CO, SO_2, and HAPs emissions. The PM_{10} and $PM_{2.5}$ scenario is termed the Construction and Development Scenario as maximum particulate emissions occur during construction of well pads and roads in close proximity to operating wells. The NO_x, CO, SO_2 and HAPs emissions scenarios are termed Operations Scenarios since the potential maximum impacts of those emissions occurs when there is a combination of drilling and wells and infrastructure operating in close proximity. One set of the Operations Scenarios is based on 40-acre surface spacing of the gas well operations with associated infrastructure located in close proximity to the wells. Another set of Operations Scenarios is based on 40-acre surface spacing but 20-acre downhole spacing (i.e., two oil wells per pad) of oil well operations in close proximity to associated infrastructure. It is possible to have one oil well and one gas well on the same pad, however, the worst case configuration is two oil wells per pad.

In all three of the near field modeling scenarios, building downwash and terrain elevations were ignored (i.e., flat terrain was assumed) because of uncertainty in location and orientation of each source. This assumption is consistent with the fact that maximum impacts occur very close to the sources (since the sources are mostly ground level releases) and the terrain in the immediate vicinity of a source will be relatively flat. There are also relatively few buildings associated with these sources, so building downwash is not an issue.

Since most of the nitrogen oxide (NO_x) emissions are nitrogen monoxide (NO) rather than nitrogen dioxide (NO_2), an assumption regarding conversion of NO to NO_2 must be made. For the 1-hour NO_2 impact, the Tier 2 analytical method as described in the USEPA March 1, 2011 memorandum (USEPA 2011b) was used. The Tier 2 method assumes a constant 80 percent conversion of the emitted NO. For the annual NO_2 impact, 100 percent conversion of NO to NO_2 was assumed.

5.2.2 Proposed Action and Alternatives Evaluation

Five different modeling scenarios were evaluated in order to assess the potential ambient air quality impacts of the Proposed Action and Alternatives. The modeling scenarios were as follows:

- Alternative A – Proposed Action: Well construction and development
- Alternative A – Proposed Action: 20-acre downhole spacing oil well operations
- Alternative A – Proposed Action: 40-acre surface spacing gas well operations
- Alternative C – Field Wide Electrification: 20-acre downhole spacing oil well operations
- Alternative C – Field Wide Electrification: 40-acre surface spacing gas well operations

Construction and well development emissions are the same under all of the Action Alternatives, so only one modeling scenario is needed. Under the No Action Alternative (Alternative B), well construction, development and operations could still occur, but the emissions and sources would be similar to Alternative A, and the near field impacts would be the similar.

5.2.3 Construction and Development Modeling Scenario

The construction and development modeling scenario focuses on particulate matter emissions, PM_{10} and $PM_{2.5}$, primarily generated by earth-moving and traffic activities. In this scenario, a section of the well field is modeled as shown in Figure 5-2. This scenario is a worst-case configuration and is not likely to occur. Receptors were placed in a rectangular grid every 100 meters from the emitting sources. The scenario contains a portion of unpaved road with six (6) road branches. At the end of one branch is well pad construction, another branch contains well development (drilling) and the rest contain producing wells.

The point source release parameters used in the Construction and Development scenario are shown in Table 5-1. Well pad construction was modeled as an area source with dimensions of 75 meters by 108 meters for oil wells (2 acres) and dimensions of 110 meters by 110 meters for gas wells (3 acres). Unpaved road emission sources were modeled as volume sources assuming a 6.7 meter wide road. Table 5-1 shows the area and volume source release parameters.

Table 5-1
Source Release Parameters for Construction and Development

Activity	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Drill Rigs	6.1	800	50	0.2
Producing Well site	3.05	700	3.8	0.1
Activity	**Release Height (m)**	**Initial Horizontal Dimension (m)**	**Initial Vertical Dimension (m)**	
Well Pad Construction	3.05	N/A	1.5	
Unpaved Road Segments	4.6	7.79	2.13	

The emission rates for each of the sources were calculated differently for short term and annual impacts. The short term emission rates were calculated by dividing the maximum short term pounds per hour by 3,600 seconds. The annual emission rates were calculated by dividing the maximum annual emissions by the number of seconds in a year. Table 5-2 shows the modeled emission rates.

Table 5-2
Emission Rates for Construction and Development Sources

Equipment	PM_{10} Hourly (g/sec)	$PM_{2.5}$ Hourly (g/sec)	$PM_{2.5}$ Annual (g/sec)
Drill Rigs – Oil Wells	7.575E-03	7.575E-03	1.245E-04
Drill Rigs – Gas Wells	7.575E-03	7.575E-03	1.141E-03
Producing Wellsite – Oil Wells	1.977E-03	1.977E-03	1.977E-03
Producing Wellsite – Gas Wells	4.225E-04	4.225E-04	4.225E-04
Well Pad Construction – Oil Wells	4.742E-02	2.607E-02	2.157E-04
Well Pad Construction – Gas Wells	4.742E-02	2.607E-02	2.166E-04
Unpaved Road Segments – Oil Wells	3.611E-03	3.611E-04	8.062E-05
Unpaved Road Segments – Gas Wells	2.887E-03	2.887E-04	7.235E-05

5.2.4 Modeling Scenario for 20-Acre Downhole Spacing Oil Operations, Alternative A

The 20-acre downhole spacing modeling scenario for oil well operations is shown in Figure 5-3. This scenario is a worst-case configuration and not likely to occur. Receptors were placed in a rectangular grid every 100 meters from the emitting sources. All emitting sources were modeled as point sources, with each well pad placed 40-acres apart (surface spacing). Most well pads contain two producing wells; however the four well pads in the center of the grid contain one well being drilled and one producing well. Additionally, the grid contains one compressor station and one GOSP facility just to the south of the drilling well pads. The point source release parameters used in this scenario for NO_2, SO_2, and CO are shown in Table 5-3, while the point source release parameters used in this scenario for the HAPs are shown in Table 5-4. For the HAP scenario either a GOSP or a Water Treatment Facility was placed in the grid depending on which facility would have higher emissions for a specific HAP.

Table 5-3
Point Source Release Parameters for 20-Acre Downhole Spacing Oil Operations -- Alternative A – NO_2, SO_2, and CO

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Compressor Engines	10.67	730	49.7	0.305
Compressor Station Heater	3.66	570	3.8	0.2
Compressor Station and GOSP Flares	6.10	1273	2.0	0.61
GOSP Generator	9.14	755	27.0	0.305
GOSP Heater	7.32	570	2.6	0.61
Drill Rigs	6.10	800	50.0	0.2
Producing Well sites	3.05	700	3.8	0.1

Table 5-4
Point Source Release Parameters for 20-Acre Downhole Spacing Oil Operations -- Alternative A – Hazardous Air Pollutants

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Producing Well sites	3.05	700	3.8	0.1
Drill Rigs	6.10	800	50.0	0.2
Compressor Engines	10.67	730	49.7	0.305
Compressor Station Tanks, Fugitives, Dehydrator	6.10	1273	2	0.61
Compressor Station Heater	3.66	570	3.8	0.2
GOSP Generator	9.14	755	27	0.305
GOSP Fugitives, Loading	1.52	350	0.5	0.1
GOSP Heater	7.32	570	2.6	0.61
Water Treatment Generator	9.14	755	27.0	0.305
Water Treatment Tanks, Fugitives	8.23	350	0.5	0.1

The emission rates for each of the sources were calculated differently for short term and annual impacts for NO_2, SO_2, and CO. The short term emission rates were calculated by dividing the maximum short term pounds per hour by 3,600 seconds. The annual emission rates were calculated by dividing the maximum annual emissions by the number of seconds in a year. For HAPs, the maximum pounds per hour were divided by 3,600 seconds for all emissions. Table 5-5 presents the modeled emission rates for NO_2, SO_2, and CO and Table 5-6 presents the modeled emission rates for HAPs.

Table 5-5
Emission Rates for 20-Acre Downhole Spacing Oil Operations -- Alternative A – NO_2, SO_2, and CO

Equipment	NO_2 Annual (g/sec)	NO_2 Hourly (g/sec)	CO Hourly (g/sec)	SO_2 Hourly (g/sec)
Compressor Engines	2.222	2.222	4.444	0.00474
Compressor Station Heater	0.0185	0.0185	0.0156	0.000111
Compressor Station and GOSP Flares	0.0257	0.0257	0.140	----
GOSP Generator	0.540	0.540	1.081	0.00130
GOSP Heater	0.408	0.408	0.342	0.00245
Drill Rigs	0.0108	0.656	0.656	0.00139
Producing Well sites	0.0205	0.0205	0.0247	0.0000617

Table 5-6
Emission Rates for 20-Acre Downhole Spacing Oil Operations -- Alternative A – Hazardous Air Pollutants

Equipment	Benzene Maximum (g/sec)	Formaldehyde Maximum (g/sec)	Acrolein Maximum (g/sec)
Producing Well sites	3.134E-04	1.620E-03	2.276E-04
Drill Rigs	6.221E-04	6.325E-05	6.317E-06
Compressor Engines	1.774E-03	2.129E-01	2.072E-02
Compressor Station Tanks, Fugitives, Dehydrator	1.743E-02	----	----
Compressor Station Heater	3.891E-07	1.390E-05	----
GOSP Generator	1.742E-03	2.261E-02	2.900E-03
GOSP Fugitives, Loading	1.186E-03	----	----
GOSP Heater	8.560E-06	3.057E-04	----
Water Treatment Generator	1.742E-03	2.261E-02	2.900E-03
Water Treatment Tanks, Fugitives	2.052E-03	----	----

5.2.5 Modeling Scenario for 40-Acre Surface Spacing Gas Operations, Alternative A

The 40-acre surface spacing modeling scenario for gas well operations is shown in Figure 5-4. This scenario is a worst-case configuration and not likely to occur. Receptors were placed in a rectangular grid every 100 meters from the emitting sources. All emitting sources were modeled as point sources, with each well pad placed 40-acres apart (surface spacing). Most well pads contain one producing well; however the four well pads in the center of the grid contain one well being drilled. Additionally, the grid contains one compressor station and one gas processing facility just to the south of the drilling well pads. The point source release parameters used in this scenario for NO_2, SO_2, and CO are shown in Table 5-7, while the point source release parameters used in this scenario for the HAPs are shown in Table 5-8.

Table 5-7
Point Source Release Parameters for 40-Acre Surface Spacing Gas Operations -- Alternative A – NO_2, SO_2, and CO

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Producing Well	3.05	700	3.8	0.1
Drill Rig	6.10	800	50.0	0.2
Compressor Engines	10.67	730	49.7	0.305
Compressor Station Heater	3.66	570	3.8	0.2
Compressor Station and Gas Plant Flares	6.10	1273	2.0	0.61
Gas Plant Engines	7.32	1013	35.2	0.15
Gas Plant Heater	3.66	570	3.8	0.2

Table 5-8
Point Source Release Parameters for 40-Acre Surface Spacing Gas Operations -- Alternative A – Hazardous Air Pollutants

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Producing Well	3.05	700	3.8	0.1
Drill Rigs	6.10	800	50.0	0.2
Compressor Engines	10.67	730	49.7	0.305
Comp Station Tanks, Fugitives, Dehydrator	6.10	1273	2.0	0.61
Compressor Station Heater	3.66	570	3.8	0.2
Gas Plant Engines	7.32	1013	35.2	0.15
Gas Plant Dehydrator, Fugitives	6.10	1273	2.0	0.61
Gas Plant Heater	3.66	570	3.8	0.2

The emission rates for each of the sources were calculated differently for short term and annual impacts for NO_2, SO_2, and CO. The short term emission rates were calculated by dividing the maximum short term pounds per hour by 3,600 seconds. The annual emission rates were calculated by dividing the maximum annual emissions by the number of seconds in a year. For HAPs, the maximum pounds per hour were divided by 3,600 seconds for all emissions. Table 5-9 presents the modeled emission rates for NO_2, SO_2, and CO and Table 5-10 presents the modeled emission rates for HAPs.

Table 5-9
Emission Rates for 40-Acre Downhole Spacing Gas Operations -- Alternative A – NO_2, SO_2, and CO

Equipment	NO_2 Annual (g/sec)	NO_2 Hourly (g/sec)	CO Hourly (g/sec)	SO_2 Hourly (g/sec)
Producing Well	0.00579	0.00579	0.00593	0.0000334
Drill Rig	0.0989	0.656	0.656	0.00139
Compressor Engines	2.222	2.222	4.444	0.00474
Compressor Station Heater	0.0185	0.0185	0.0156	0.000111
Compressor Station and Gas Plant Flares	0.0257	0.0257	0.140	----
Gas Plant Engines	0.333	0.333	0.167	0.000200
Gas Plant Heater	0.0185	0.0185	0.0156	0.000111

Table 5-11
Point Source Release Parameters for 20-Acre Downhole Spacing Oil Operations -- Alternative C – NO_2, SO_2, and CO

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Producing Well	3.05	700	3.8	0.1
Drill Rigs	6.10	800	50.0	0.2
Turbines	9.14	736	50.2	1.07
GOSP Heater	7.32	570	2.6	0.61
Compressor Station and GOSP Flares	6.10	1273	2.0	0.61
Compressor Station Heater	3.66	570	3.8	0.2

Table 5-12
Point Source Release Parameters for 20-Acre Downhole Spacing Oil Operations -- Alternative C – Hazardous Air Pollutants

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Turbines	9.14	736	50.2	1.07
Producing Well	3.05	700	3.8	0.1
Drill Rigs	6.10	800	50.0	0.2
Compressor Station Tanks, Fugitives, Dehydrator	6.10	1273	2.0	0.61
Compressor Station Heater	3.66	570	3.8	0.2
GOSP Fugitives, Loading	1.52	350	0.5	0.1
GOSP Heater	7.32	570	2.6	0.61
WT Tanks, Fugitives	8.23	350	0.5	0.1

The emission rates for each of the sources were calculated differently for short term and annual impacts for NO_2, SO_2, and CO. The short term emission rates were calculated by dividing the maximum short term pounds per hour by 3,600 seconds. The annual emission rates were calculated by dividing the maximum annual emissions by the number of seconds in a year. For HAPs, the maximum pounds per hour were divided by 3,600 seconds for all emissions. Table 5-13 presents the modeled emission rates for NO_2, SO_2, and CO and Table 5-14 presents the modeled emission rates for HAPs.

Table 5-13
Emission Rates for 20-Acre Downhole Spacing Oil Operations -- Alternative C – NO_2, SO_2, and CO

Equipment	NO_2 Annual (g/sec)	NO_2 Hourly (g/sec)	CO Hourly (g/sec)	SO_2 Hourly (g/sec)
Producing Well	0.00755	0.00755	0.00698	0.0000445
Drill Rigs	0.0108	0.656	0.656	0.00139
Turbines	0.274	0.274	0.250	0.00534
GOSP Heater	0.408	0.408	0.342	0.00245
Compressor Station and GOSP Flares	0.0257	0.0257	0.140	----
Compressor Station Heater	0.0185	0.0185	0.0156	0.000111

Table 5-14
Emission Rates for 20-Acre Downhole Spacing Oil Operations -- Alternative C – Hazardous Air Pollutants

Equipment	Benzene Maximum (g/sec)	Formaldehyde Maximum (g/sec)	Acrolein Maximum (g/sec)
Turbines	3.970E-04	2.349E-02	2.118E-04
Producing Well	2.567E-04	5.559E-06	----
Drill Rigs	6.221E-04	6.325E-05	6.317E-06
Compressor Station Tanks, Fugitives, Dehydrator	1.743E-02	----	----
Compressor Station Heater	3.891E-07	1.390E-05	----
GOSP Fugitives, Loading	1.186E-03	----	----
GOSP Heater	8.560E-06	3.057E-04	----
WT Tanks, Fugitives	2.052E-03	----	----

5.2.7 Modeling Scenario for 40-Acre Surface Spacing Gas Operations, Alternative C

The 40-acre surface spacing modeling scenario for gas well operations is shown in Figure 5-6. This scenario is a worst-case configuration and not likely to occur. Receptors were placed in a rectangular grid every 100 meters from the emitting sources. All emitting sources were modeled as point sources, with each well pad placed 40-acres apart (surface spacing). Most well pads contain one producing well; however the four well pads in the center of the grid contain one well being drilled. Additionally, the grid contains one compressor station, one gas processing facility, and one electric substation just to the south of the drilling well pads. The point source release parameters used in this scenario for NO_2, SO_2, and CO are shown in Table 5-15, while the point source release parameters used in this scenario for the HAPs are shown in Table 5-16.

Table 5-15
Point Source Release Parameters for 40-Acre Surface Spacing Gas Operations -- Alternative C – NO_2, SO_2, and CO

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Producing Well	3.05	700	3.8	0.1
Drill Rig	6.10	800	50.0	0.2
Turbines	9.14	736	50.2	1.07
Gas Plant Heater	3.66	570	3.8	0.2
Compressor Station and Gas Plant Flare	6.10	1273	2.0	0.61
Compressor Station Heater	3.66	570	3.8	0.2

Table 5-16
Point Source Release Parameters for 40-Acre Surface Spacing Gas Operations -- Alternative C – Hazardous Air Pollutants

Equipment	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Producing Well	3.05	700	3.8	0.1
Drill Rig	6.10	800	50.0	0.2
Turbines	9.14	735.93	50.2	1.07
Gas Plant Heater	3.66	570	3.8	0.2
Gas Plant Dehydrator, Fugitives	6.10	1273	2.0	0.61
Compressor Station Tanks, Fugitive, Dehydrator	6.10	1273	2.0	0.61
Compressor Station Heater	3.66	570	3.8	0.2

The emission rates for each of the sources were calculated differently for short term and annual impacts for NO_2, SO_2, and CO. The short term emission rates were calculated by dividing the maximum short term pounds per hour by 3,600 seconds. The annual emission rates were calculated by dividing the maximum annual emissions by the number of seconds in a year. For HAPs, the maximum pounds per hour were divided by 3,600 seconds for all emissions. Table 5-17 presents the modeled emission rates for NO_2, SO_2, and CO and Table 5-18 presents the modeled emission rates for HAPs.

Table 5-17
Emission Rates for 40-Acre Downhole Spacing Gas Operations -- Alternative C – NO_2, SO_2, and CO

Equipment	NO_2 Annual (g/sec)	NO_2 Hourly (g/sec)	CO Hourly (g/sec)	SO_2 Hourly (g/sec)
Producing Well	0.00579	0.00579	0.00593	0.0000334
Drill Rig	0.0989	0.656	0.656	0.00139
Turbines	0.274	0.274	0.250	0.00534
Gas Plant Heater	0.0185	0.0185	0.0156	0.000111
Compressor Station and Gas Plant Flare	0.0257	0.0257	0.140	----
Compressor Station Heater	0.0185	0.0185	0.0156	0.000111

Table 5-18
Emission Rates for 40-Acre Downhole Spacing Gas Operations -- Alternative C – Hazardous Air Pollutants

Equipment	Benzene Maximum (g/sec)	Formaldehyde Maximum (g/sec)	Acrolein Maximum (g/sec)
Producing Well	3.009E-04	4.169E-06	----
Drill Rig	6.221E-04	6.325E-05	6.317E-06
Turbines	3.970E-04	2.349E-02	2.118E-04
Gas Plant Heater	3.891E-07	1.390E-05	----
Gas Plant Dehydrator, Fugitives	1.613E-02	----	----
Compressor Station Tanks, Fugitive, Dehydrator	1.743E-02	----	----
Compressor Station Heater	3.891E-07	1.390E-05	----

5.2.8 Near Field Evaluation Criteria

The modeled impacts for criteria pollutants were added to the pre-project background concentrations shown in Table 3-3 and compared to the NAAQS shown in Table 3-1. The modeled impacts for potential non-carcinogenic HAPs were compared to the RELs and RfCs shown in Table 3-4 and the State of Utah TSLs shown in Table 3-5. Potential carcinogenic risk was calculated as discussed in Section 3.4 and compared to the standard acceptable risk range of 1 to 100 in a million. As shown in Tables 3-4 and 3-5, the three HAPs with the most stringent REL and RfCs are benzene, formaldehyde, and acrolein; and only benzene and formaldehyde are potentially carcinogenic. Accordingly, only benzene, formaldehyde, and acrolein impacts were modeled in the Near Field assessment; although all of the HAP emissions were quantified and are included in the Appendices.

5.3 Far Field AQIA

5.3.1 Dispersion Modeling

To assess the potential impacts of the Proposed Action and Alternatives on distant (i.e., greater than 50 km) receptors at Class I areas, sensitive Class II areas, and sensitive lakes, the CALPUFF modeling system (Version 5.8) was used. The CALPUFF modeling system consists of three major modules, CALMET, CALPUFF, and CALPOST. For the far field AQIA, only the CALPUFF (Version 5.8, Level 070623) and CALPOST (Version 6.221, Level 080724) modules were used. The CALMET module was not needed as the WRF (Weather Research and Forecasting meteorological model) meteorological data prepared for the Air Resource Management Strategy (ARMS) photochemical modeling project currently being conducted by the BLM were used. When appropriate, the CALPUFF and CALPOST modeling procedures in the Federal Land Manager's Air Quality Related Values Work Group (FLAG) October 2010 guidance (FLAG 2010) were used, including the updated Method 8 equations for regional haze impact assessments. Default settings were used in CALPUFF and CALPOST if not otherwise specified by the FLAG guidance. The WRF data were made "CALPUFF ready" by processing with the MMIF processor (Version 2.3). The MMIF processor simply re-formats the meteorological data to be useable in CALPUFF without any adjustments or supplementary meteorological observations.

The CALPUFF modeling domain covered eastern Utah and western Colorado as shown in Figure 5-7. The modeling domain was the same as used in the Greater Natural Buttes FEIS (BLM 2012) and extended 672 km east-west and 552 km north-south. The central reference point for the Lambert Conformal Projection (LCP) was 97 degrees west, 40 degrees north. The LCP standard parallels were 33 and 45 degrees north. The southwest corner of the modeling domain was located 1,392 km west of the central reference point and 312 km south of the central reference point. The modeling domain was a 4 km grid with 168 x 138 grid cells.

The WRF meteorological data utilize two different domains, a 4 km domain and a 12 km domain. The WRF 4 km domain does not include all of the Class I, sensitive Class II, and sensitive lake receptors evaluated herein. Accordingly, the far field impact assessment was completed with the 12 km domain. However, the 12 km domain results for visibility and NO_2 impacts for Arches National Park and Dinosaur National Monument were compared to the 4 km domain results and it was found that the 4 km domain results were the same or slightly lower than the 12 km domain results. Therefore, the 12 km domain was used for all of the far field impact assessments.

The list of Class I areas, sensitive Class II areas, and sensitive lakes are shown in Table 5-19. Locations of these areas with respect to the MBPA are shown in Figure 5-8.

The receptor grids for the Class I areas were those specified by the Federal Land Managers. Receptor grids were developed for the sensitive Class II areas based on the boundary of the area and a rectangular receptor grid at approximately 1.5 km spacing within the area. Single receptors at the center of each the sensitive lakes was used. Elevations for the receptors were developed where necessary from the USGS Shuttle Radar Topography Mission data with 30 meter with 90 meter resolution (USGS 2013).

Table 5-19
Class I Areas, Sensitive Class II Areas, and Sensitive Lakes Evaluated

Class I and Sensitive Class II Areas	Sensitive Lakes	
National Park Service (NPS) Class I Areas	**Eagles Nest Wilderness**	**High Uintas Wilderness**
Arches National Park	Booth Lake	Dean Lake
Black Canyon of the Gunnison National Park	Upper Willow Lake	Fish Lake
Canyonlands National Park	**Flat Tops Wilderness**	**Raggeds Wilderness**
Capitol Reef National Park	Ned Wilson Lake	Deep Creek Lake
Great Sand Dunes National Park and Preserve	Trappers Lake	Island Lake
Mesa Verde National Park	Upper Ned Wilson Lake	
USFS Class I Areas	**La Garita Wilderness**	
Eagles Nest Wilderness Area	Small Lake Above U-Shaped Lake	
Flat Tops Wilderness Area	U-Shaped Lake	
La Garita Wilderness Area	**Maroon Bells-Snowmass Wilderness**	
Maroon Bells-Snowmass Wilderness Area	Avalanche Lake	
Mount Zirkel Wilderness Area	Capitol Lake	
Weminuche Wilderness Area	Moon Lake (Upper)	
West Elk Wilderness Area	**Mount Zirkel Wilderness**	
NPS Class II Areas	Lake Elbert	
Colorado National Monument	Summit Lake	
Dinosaur National Monument	**Weminuche Wilderness**	
USFS Class II Areas	Big Eldorado Lake	
Flaming Gorge National Recreation Area	Little Eldorado Lake	
High Uintas Wilderness Area	Lower Sunlight Lake	
Holy Cross Wilderness Area	Upper Grizzly Lake	
Hunter/Frying Pan Wilderness Area	Upper Sunlight Lake	
Raggeds Wilderness Area	White Dome Lake	
U.S. Fish and Wildlife Service Class II Areas	**West Elk Wilderness**	
Browns Park National Wildlife Refuge	South Golden Lake	

5.3.2 Proposed Action and Alternatives Evaluation

The far field impact analysis included only NO_x, SO_2, PM_{10}, and $PM_{2.5}$. CO was not modeled because there are no PSD increments for CO and CO impacts are a local, near field issue. Similarly for HAP emissions, the impact of interest is local. For the far field impact evaluation only Alternative A was modeled. This Alternative has the largest emissions of any of the Alternatives and thus yields the maximum impact of any of the Alternatives.

Since the Class I areas, sensitive Class II areas and sensitive lakes are all located a considerable distance from the MBPA, the emissions for the entire Alternative A were placed into a single rectangular area source that can be fit within the MBPA. This is a rectangular source of 11 km by 13 km. The emissions were then calculated as grams per second per square meter (g/sec-m^2) by dividing the maximum tons per year by the number of seconds in a year and the area of the source. A single set of emission rates can be used for both short and long term impacts because most of the sources emit continuously at the same rate (e.g., a pumpjack engine runs continuously at the same load). The sources emit at essentially ground level, so the release height for the area source was set as ground level at the average elevation of the MBPA, 1432 meters above mean sea level. The modeled emission rates are shown in Table 5-20.

Table 5-20
Far Field Modeling Emission Rates

	NO_x (g/sec-m^2)	**SO_2** (g/sec-m^2)	**PM_{10}** (g/sec-m^2)	**$PM_{2.5}$** (g/sec-m^2)
CALPUFF Modeled Emission Rates	4.8E-07	1.20E-09	2.45E-07	5.20E-08

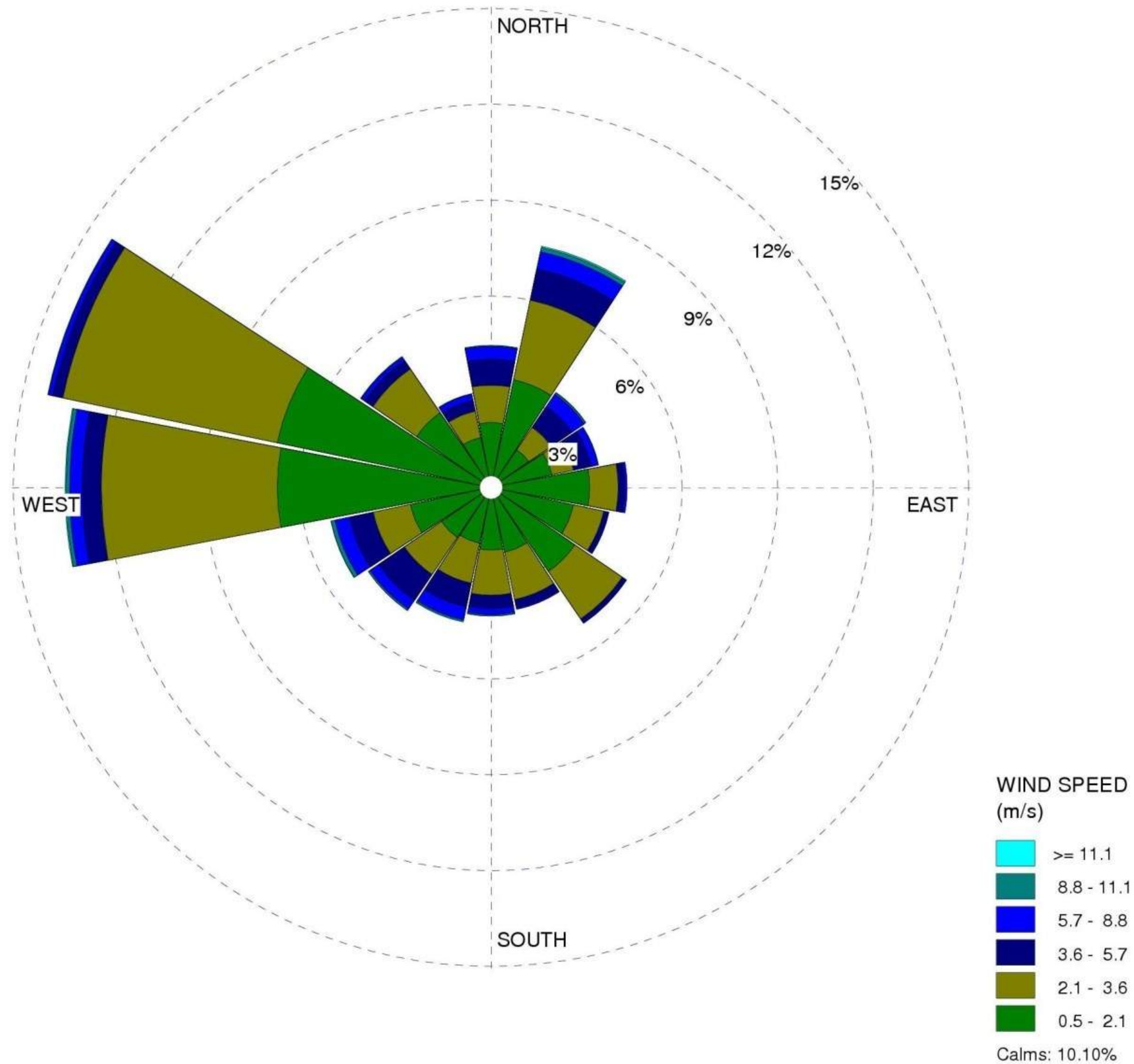
5.3.3 Far Field Evaluation Criteria

As a point of information only, the impacts of the Proposed Action in the Class I and sensitive Class II areas were compared to the PSD increments for the pollutants and averaging times for which increments have been established by the USEPA as shown in Table 3-1. As indicated in Section 3, comparisons with PSD increments are intended as a point of reference only and do not represent a regulatory PSD increment consumption analysis

For regional haze, the potential change in light extinction (b_{ext}) in terms of change in deciviews (dV) was evaluated using the CALPUFF Method 8 and the regional haze equations suggested by FLAG in the 2010 guidance (FLAG 2010). Method 8 and the FLAG 2010 guidance treat large sulfate and small sulfate separately because large and small particles affect light extinction differently. The modeled impacts were evaluated by calculating the number of days in each area that exceeded the 0.5 dV and 1.0 dV thresholds of concern used by USEPA in its Regional Haze regulations and the eighth-high (98th percentile) change in bext compared to the 0.5 dV threshold published by the Federal Land Managers (FLAG 2010).

Acid deposition was evaluated by calculating total sulfur and nitrogen deposition (dry plus wet) from the CALPUFF model output (in terms of kilograms sulfur or nitrogen per hectare per year, kg/ha-yr). The deposition was compared to the 3 kg/ha-yr and 5 kg/ha-yr thresholds for nitrogen and sulfur, respectively.

For sensitive lakes, the change in acid neutralizing capacity (ANC) was calculated using the methodology suggested by the US Forest Service (USFS 2000). The method is to calculate hydrogen ion deposition (H_{dep}) in terms of micro equivalents per liter (µeq/l) from the watershed area and total sulfur and nitrogen deposition of all species output by CALPUFF. The watershed areas were those used in the GNB analysis (BLM 2012) and were provided by the Federal Land Managers. H_{dep} is compared to the baseline ANC (ANC(o)), also reported in the GNB analysis as provided by the Federal Land Managers. The change in ANC was compared to the threshold of a 10 percent change in ANC for lakes with background ANC values greater than 25 µeq/l and no more than a 1 µeq/l change in ANC for lakes with background ANC values equal to or less than 25 µeq/l.



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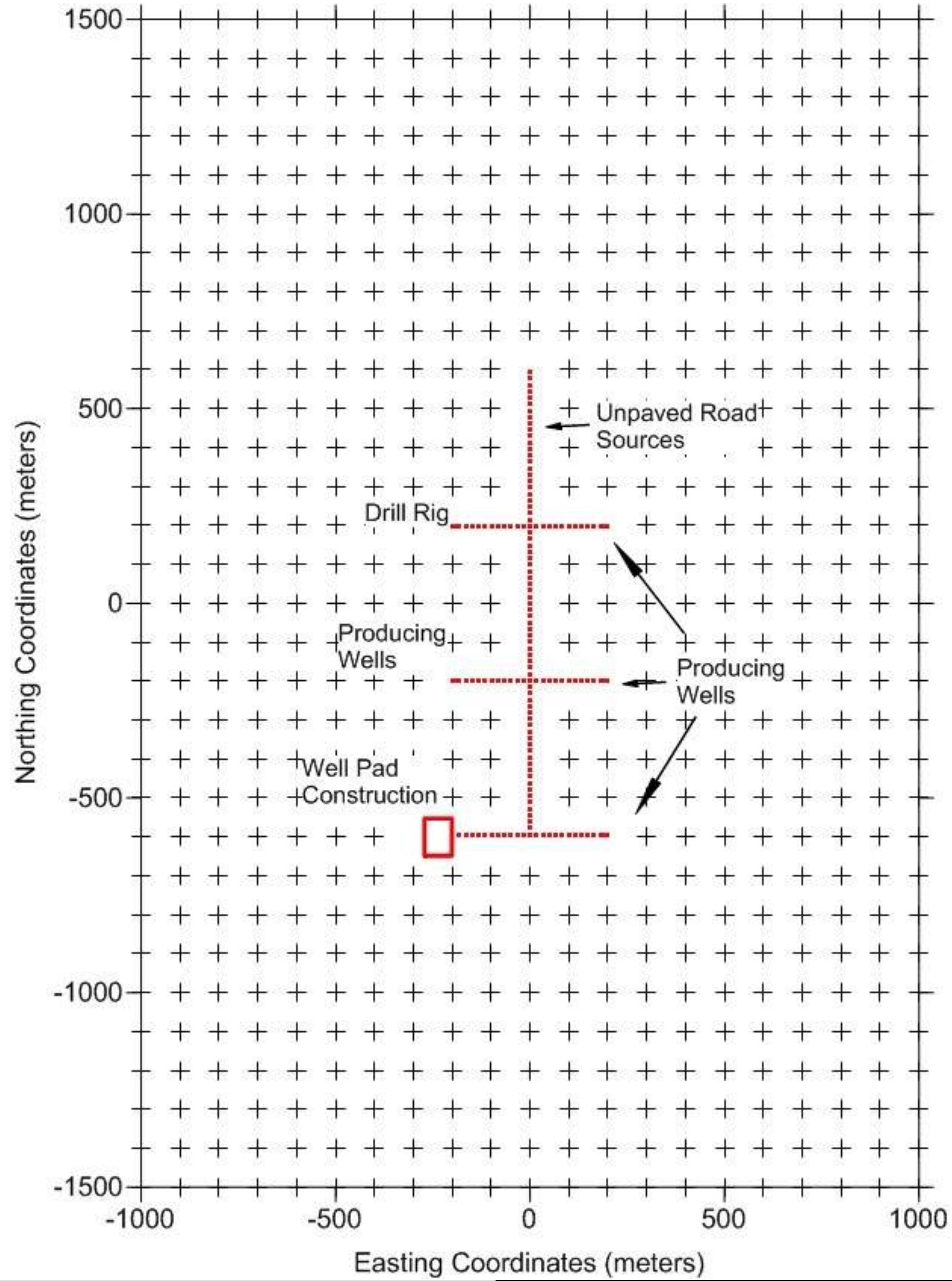
Monument Butte

Wind Rose for Vernal, Utah
2005-2009 Data

FIGURE
5-1



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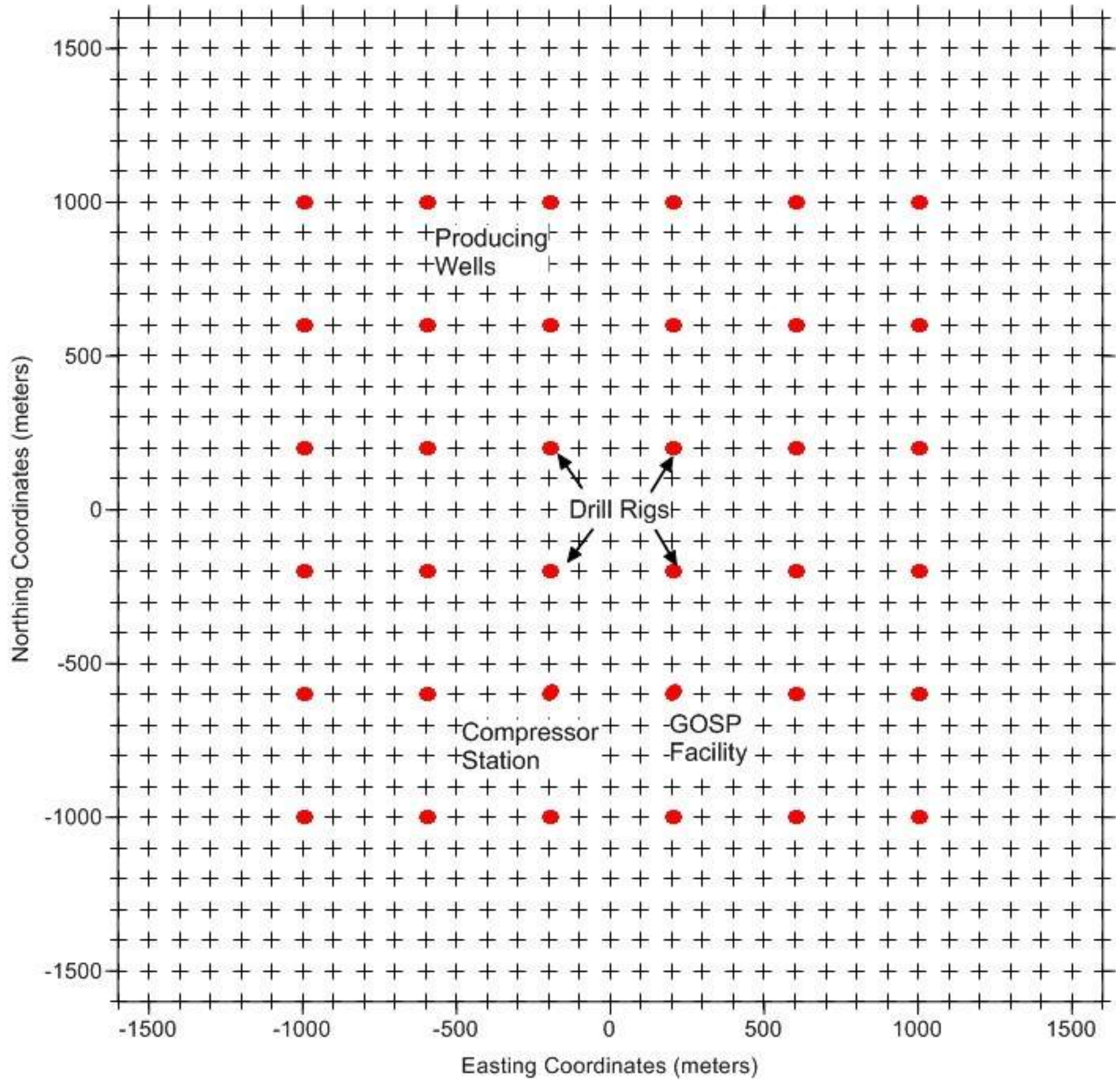
Construction and Development
Modeling Scenario Configuration

FIGURE
5-2



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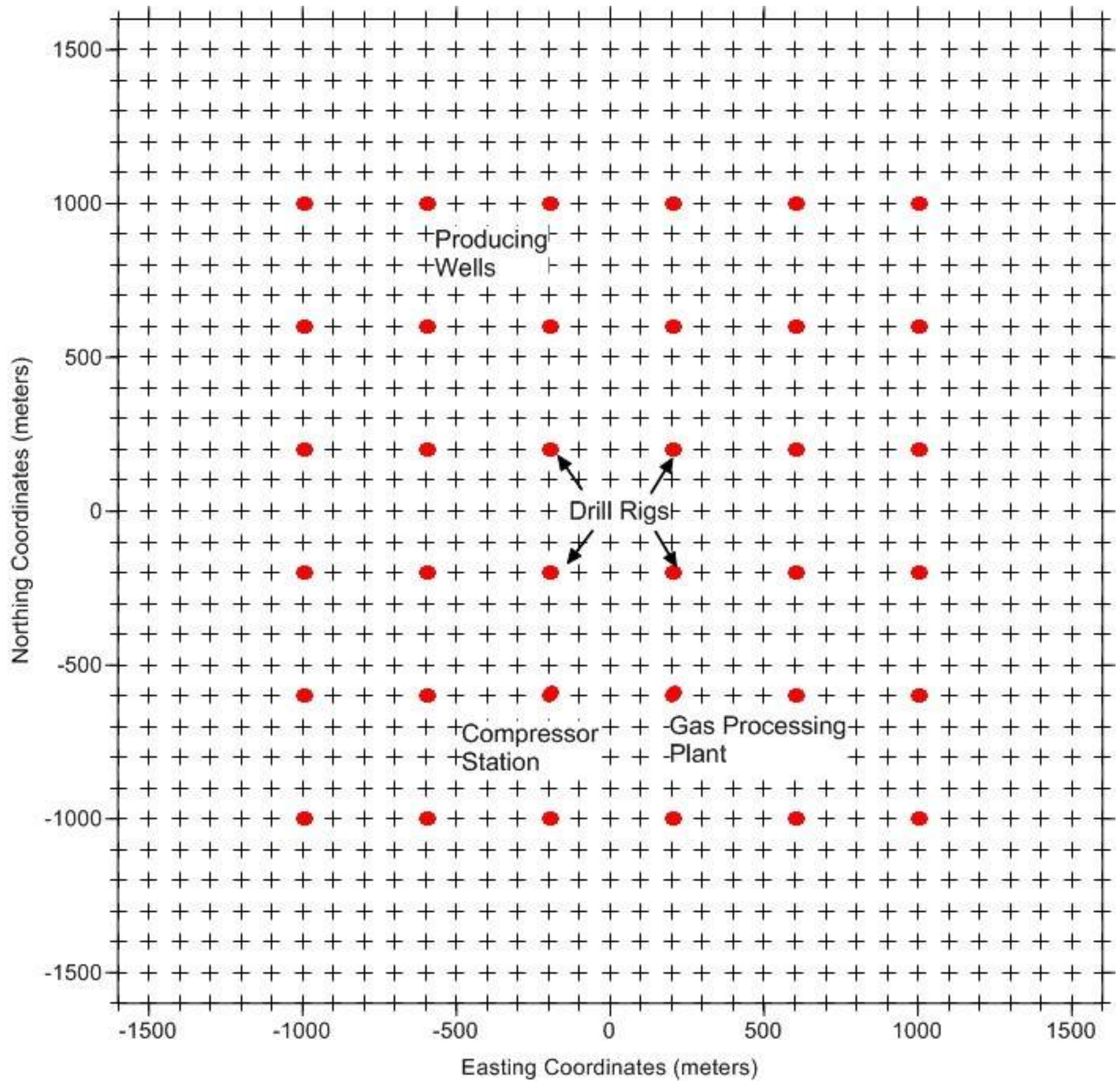
Monument Butte

Alternative A
20-acre Downhole Spacing (40-acre Surface Spacing)
Oil Well Modeling Scenario Configuration

FIGURE
5-3



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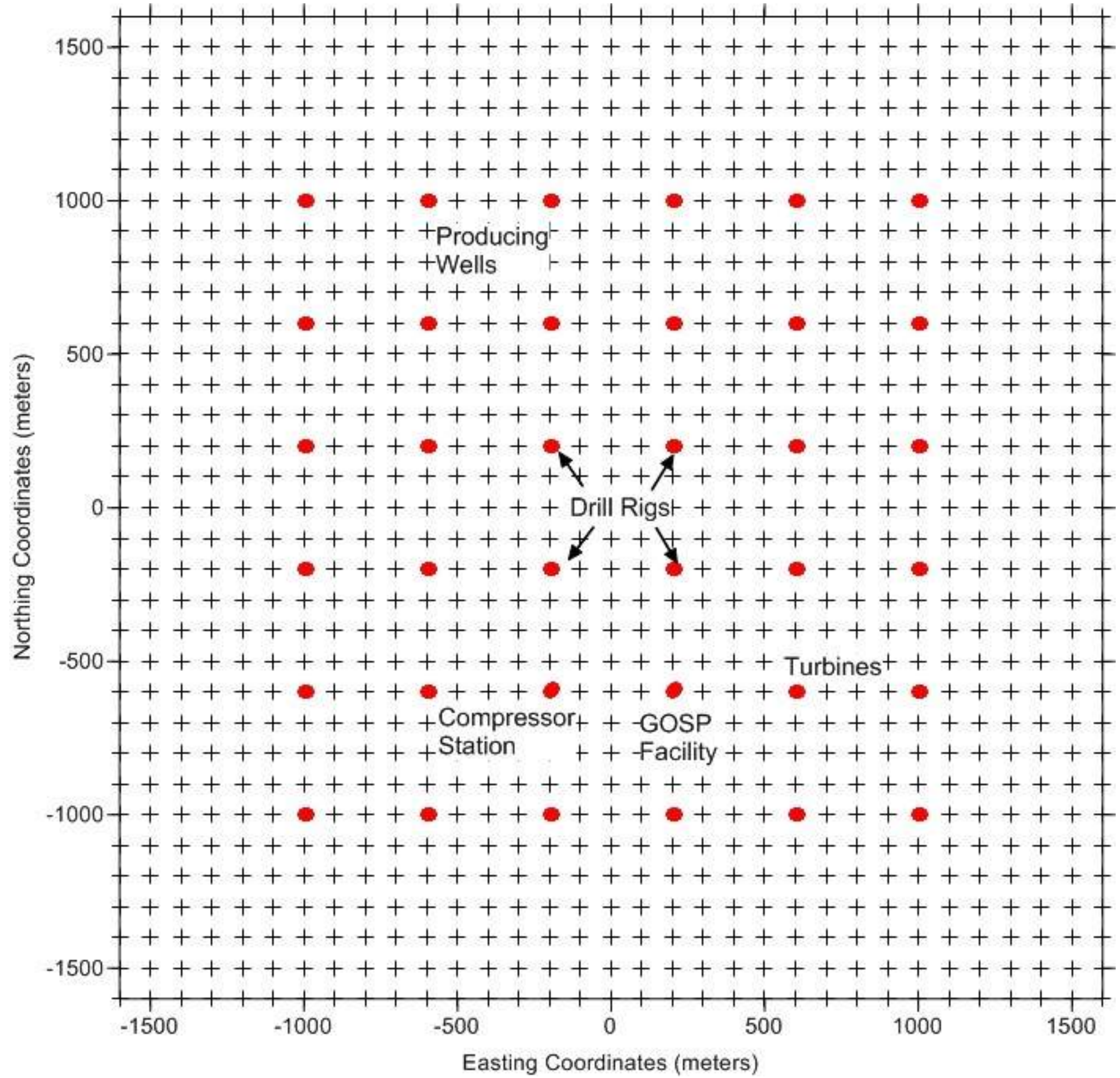
Monument Butte

Alternative A
40-acre Surface Spacing Gas Well
Modeling Scenario

FIGURE
5-4



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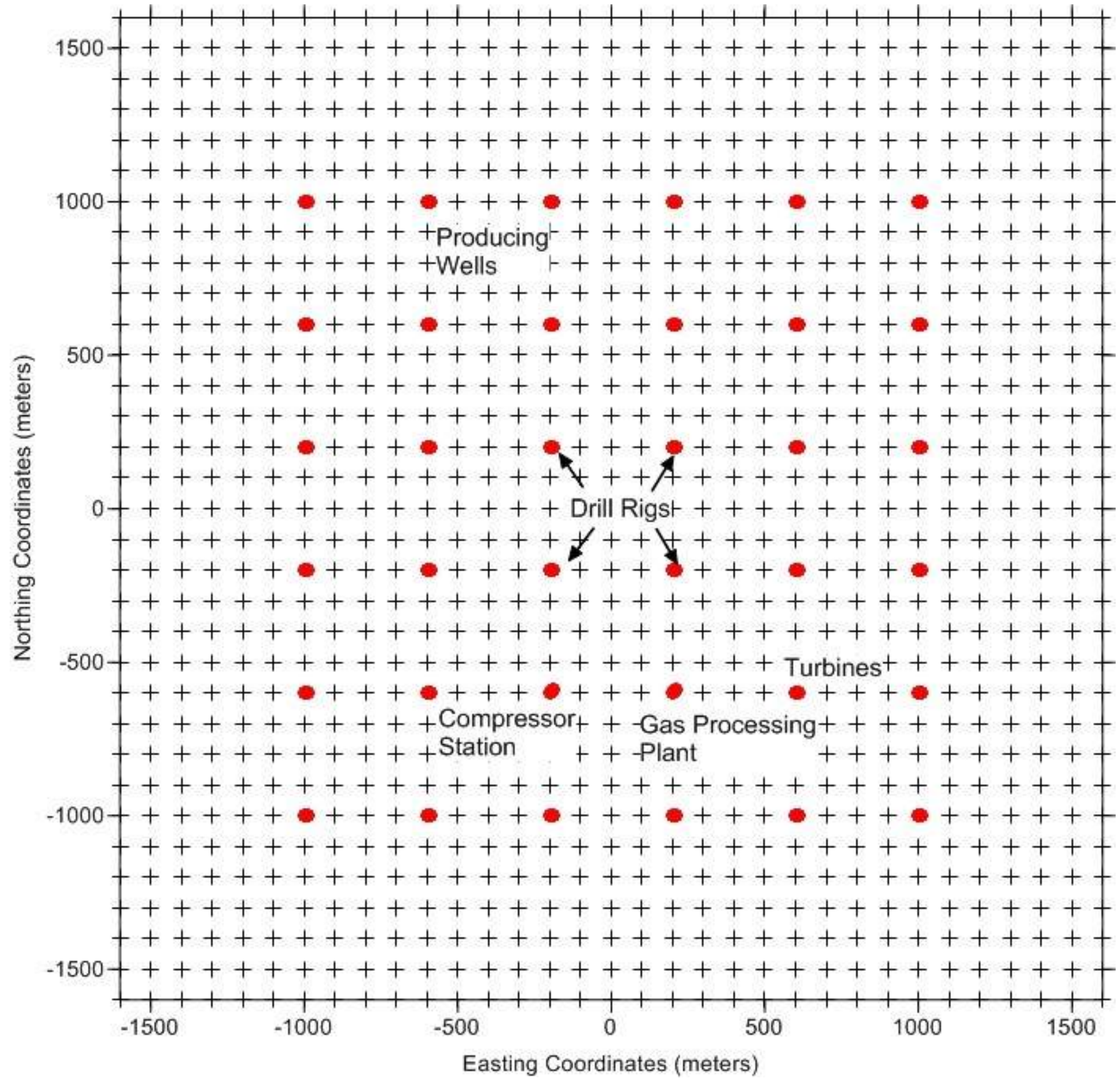
Monument Butte

Alternative C
20-acre Downhole Spacing (40-acre Surface Spacing)
Oil Well Modeling Scenario Configuration

FIGURE
5-5



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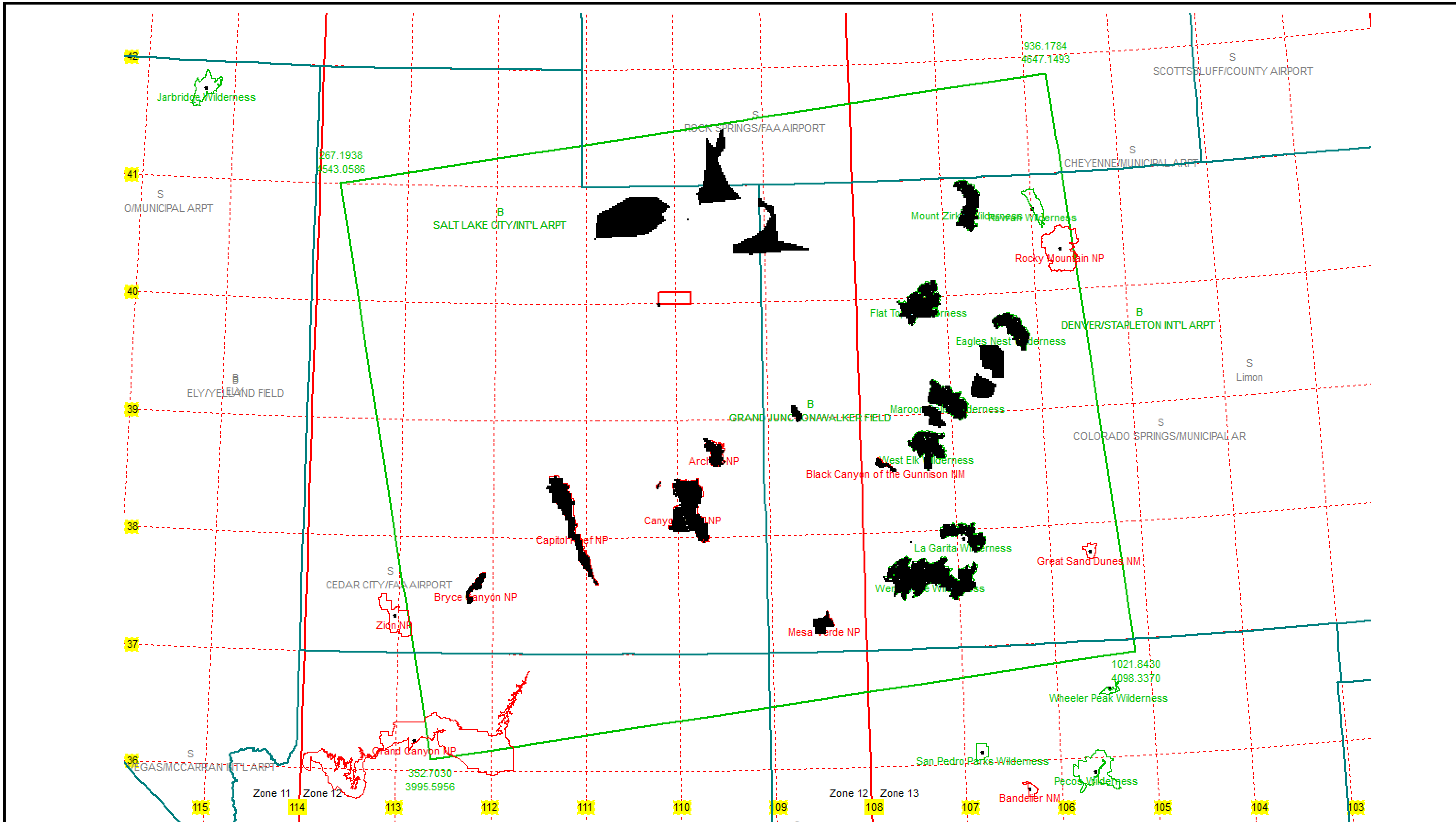
Monument Butte

Alternative C
40-acre Surface Spacing Gas Well
Modeling Scenario

FIGURE
5-6



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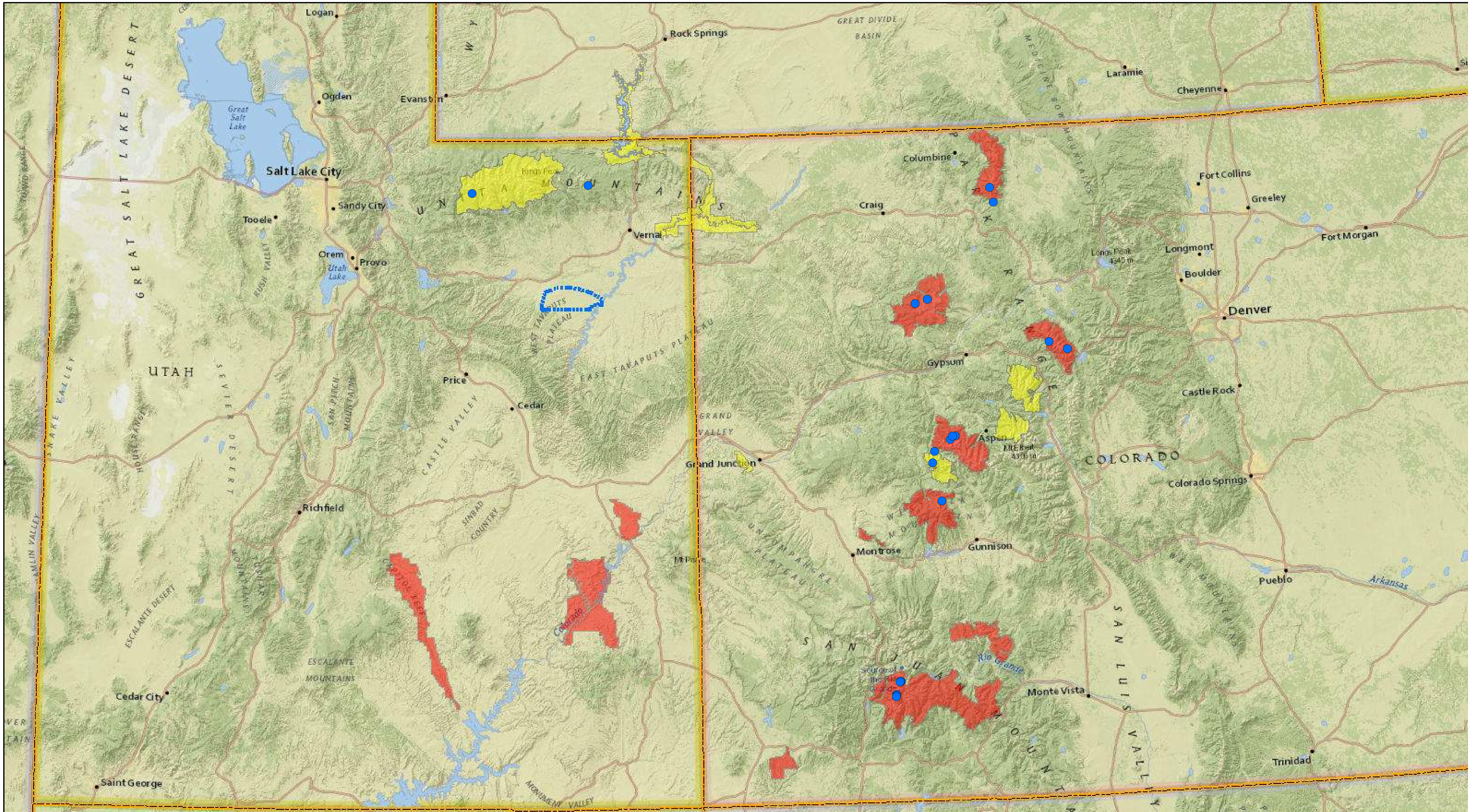
Monument Butte

CALPUFF Modeling Domain
Colorado and Utah

FIGURE
5-7



Legend

- Sensitive Lakes
- Class I Areas
- Class II Areas
- GMBU Project Boundary
- State Boundary

0 12.5 25 50 Miles

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Monument Butte

Location of Class I and Class II Sensitive Lakes
Colorado and Utah

FIGURE
5-8

6 SUBSTANTIAL INCREASE IN EMISSIONS EVALUATION

6.1 Emission Increases

To determine if the Proposed Action and Alternatives could result in a substantial increase in ozone precursor emissions, the projected annual development emissions in Table 4-2 were compared to the No Action Alternative emissions shown in Table 4-3. The results are summarized in Table 6-1 and shown graphically in Figures 6-1 through 6-3 which are located at the end of this Section. Figure 6-1 shows this comparison for the projected NO_x emissions, Figure 6-2 shows the projected VOC emissions, and Figure 6-3 shows the sum of NO_x plus VOC emissions.

Table 6-1
Comparison of Annual Proposed Action Development Emission Increases Compared to No Action Development Emission Increases
(tons per year)

Year	Annual Development Proposed Action Projected Annual NO_x Increases	NO_x Emission Increases under No Action Alternative (from Table 4-3) [a]	Annual Development Proposed Action Projected Annual VOC Increases	VOC Emission Increases under No Action Alternative (from Table 4-3) [a]	Annual Development Proposed Action Projected Annual NO_x + VOC Increases	NO_x + VOC Emission Increases under No Action Alternative (from Table 4-3) [a]
2012	-53	1,817 [b]	25	2,117 [b]	-28	3,934 [b]
2013	-172		-603		-775	
2014	-311		-684		-995	
2015	-387		-545		-932	
2016	-320		-99		-415	
2017	-149		580		431	
2018	-16		1,383		1,367	
2019	194		2,213		2,407	
2020	378		3,086		3,464	
2021	561		3,959		4,520	
2022	745		4,833		5,578	

[a] The No Action Alternative analysis date was chosen as December 31, 2012. The annual development projections provided by Newfield used an analysis date of December 31, 2011. However, as the table shows, there is essentially no difference in emissions for calendar year 2012 (less than 0.5 percent of the total NOx plus VOC).
[b] The No Action Alternative emissions increase will occur during the first two to three years and then remain constant (because no more wells could be developed under the No Action Alternative). It is not known what the rate of emission increases could be under the No Action Alternative, thus the emission increases have been presented as a single value in the Table.

By December 31, 2022, Newfield could develop up to a net of 1,594 additional oil and gas wells in the MBPA. Table 6-2 shows the emissions and activities for the Proposed Action development by calendar 2022 compared to the No Action Alternative. Development of the Proposed Action can continue into approximately early calendar year 2021 for total ozone precursor (NOx plus VOC) emissions, late 2019 for VOC emissions alone, and beyond 2022 for NOx emissions alone without causing an increase greater than the No Action Alternative. Under the Proposed Action, emissions of NOx will decrease until about calendar year 2019 and then increase but will remain less than the No Action Alternative until at least 2022. VOC emissions will also decrease under the Proposed Action through about 2016, but by about 2019 will exceed emissions that would occur under the No Action Alternative. The reason development of this magnitude could occur without a substantial increase in total ozone precursor emissions is because Newfield will implement a number of emission reducing measures in the MBPA that reduce emissions from existing and future oil and gas wells. These measures include the Applicant Committed Environmental Protection Measures (ACEPMs) and the following:

- By year 2022, it is expected that all of the old pumpjack engines in the MBPA will have been replaced with newer low emitting engines.
- At the end of 2022, it is projected that there will be 1,138 oil wells in the MBPA that will be sharing storage tanks and those tanks will have emission controls.
- A projected total of 150 additional oil wells will be routed to a Gas Oil Separator Plant (GOSP), where emissions from the storage tanks are controlled 100 percent.
- Tier 4 drill rig engines will be used in 2022.
- It is anticipated that gas associated with oil development can be processed by the existing infrastructure through 2022.

Table 6-2
Annual Development and Production Emissions for Calendar Year 2022 Compared to the No Action Alternative

1	2	3	4	5	6	7	8
	Cumulative Net Change in NO_x from December 31, 2011 (tpy)	**Cumulative Net Change in VOC from December 31, 2011** (tpy)	**Cumulative Net Change in NO_x plus VOC from December 31, 2011** (tpy) (2+3)	**Cumulative Oil Wells Added**	**Cumulative Gas Wells Added**	**Cumulative Wells Shut In or Converted to Water Injection**	**Cumulative Net Change in Number of Oil and Gas Producing Wells from December 31, 2011** (5+6-7)
Annual Development and Production Emission Increases from December 31, 2011 through December 31, 2022 as Projected by Newfield for the MBPA (from Attachment C and Table 6-1)	745	4,833	5,578	2,496 [a]	48 [a]	950	1,594
Development and Production Emission Increases under the No Action Alternative (from Table 6-1 and discussion in Section 4.3) [b]	1,817	2,117	3,934	579	209	Not specified, but wells will be converted or shut in such that there results in a total of 788 oil and gas producing wells.	788 producing oil and gas well increase

[a] The Proposed Action includes development of up to 2,500 deep gas wells. However, through December 31, 2022, Newfield projects that only 48 of those wells will be developed. The Proposed Action also includes up to 1,800 wells served by GOSPs, but through December 31, 2022, Newfield projects only 150 wells going to a GOSP.

[b] The No Action analysis date is December 31, 2012, but as shown in Table 6-1, is essentially no difference in emissions as of December 31, 2011 compared to December 31, 2012.

The emissions from the Proposed Action are much less than would occur without implementation of the Applicant Committed Environmental Protection Measures (ACEPMs). The ACEPMs are applied annually and to the Ultimate Proposed Action. The benefit of the key measures in reducing NO_x and VOC emissions are shown in Table 6-3. The list focuses only on NO_x and VOC

ACEPMs, although there are other ACEPMs that also reduce other pollutants as well as reduce other potential environmental impacts. Some of the ACEPMs may be required by USEPA regulations; however, the ACEPMs will be implemented even if no regulatory requirement exists.

Table 6-3
Benefit of ACEPMs for NO_x and VOC Emissions for the Ultimate Proposed Action
(tons per year)

Key NOx and VOC ACEPM	NOx without ACEPM	NOx with ACEPM	ACEPM NOx Benefit	Percent NOx Reduction	VOC without ACEPM	VOC with ACEPM	ACEPM VOC Benefit	Percent VOC Reduction
Pumpjack Engines	2,836	1,465	-1,371	48%	827	397	-430	52%
Tank Controls (GOSP, centralization, and/or flares)	0	1.7 (from flares)	+1.7	N/A	8,304	3,488	-4,816	58%
Tier 4 Drill Rig Engines	1,132	613	-519	46%	236	33	-203	86%
Dehydrator Still Vent Emission Control	0	20 (from flares)	+20	N/A	946	47	-899	95%
Convert Wells to Waterflood Injection	1,256	0	-1,256	100%	1,868	0	-1,868	100%
Total	**5,224**	**2,100**	**-3,124**	**60%**	**12,181**	**3,965**	**-8,216**	**67%**

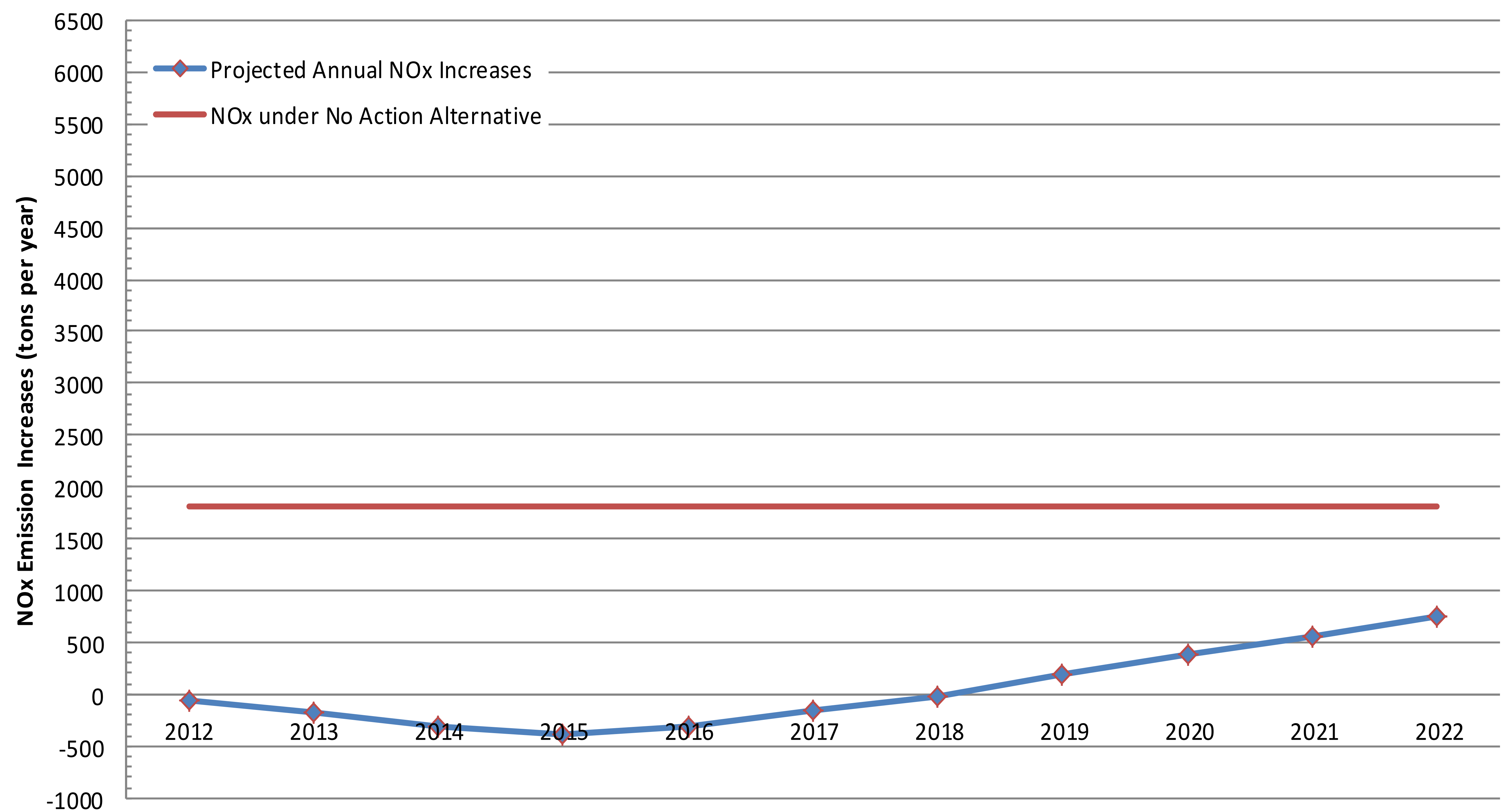
The benefits of the ACEPMs were calculated as follows:

- Pumpjack Engines: The benefit is calculated based on 3,250 new engines (i.e., 100 percent of the 3,250 new oil wells at full development of the Proposed Action) compared to 31 percent new engines (1,007 new engines and 2,243 old engines). The 31 percent value is based on the estimated current (as of December 31, 2012) percentage of new engines in the field.
- Tank Emissions: Emissions from full build out with ACEPMs includes (12 gas and oil separation facilities (GOSPs) receiving produced fluids from 150 oil wells each (1800 total) and an additional 724 oil wells that share 2 oil storage tanks between two wells that are controlled with a vapor combustor with 95% control efficiency. The storage tank vapors at the GOSPs are used in the process or sold as product and are not considered to be emissions. If GOSPs are not feasible, then the 1,800 tanks that would have gone to a GOSP will be controlled by other means (VRU or smokeless combustors). The remaining

storage tanks that do not go to a GOSP or are not served by a common battery with controls are assumed to be uncontrolled.

- Drill Rig Engines: The benefit is calculated based on drilling 156 gas wells and 204 oil wells (360 total wells per year) with Tier 4 drill rigs versus with Tier 2 drill rigs.
- Dehydrator Still Vent Emissions: The benefit is calculated based on controlling all well-site dehydrators with flares with 95% control efficiency versus not controlling the well-site dehydrators. The dehydrators include 2,500 well-site dehydrators at the gas wells. There are an additional 24 dehydrators at the compressor stations and 1 dehydrator at the gas processing plant, but it is assumed that these 25 dehydrators would have to be controlled under current regulations, thus the emission reduction from those controls are not considered an ACEPM benefit.
- Well Conversions: The benefit is calculated as if 950 oil wells had not been converted to water injection wells. The emissions include all production emissions including storage tank emissions, heaters, pumpjack engines, pneumatics, fugitives, tanker truck loading, and operation vehicle tailpipe. It was assumed that the 950 converted wells were low producers at 2 barrels/day average prior to conversion. For the 950 wells, prior to conversion it was assumed that there were two storage tanks per well and the tanks were not controlled.

Projected NOx Emission Increases Compared to No Action Alternative



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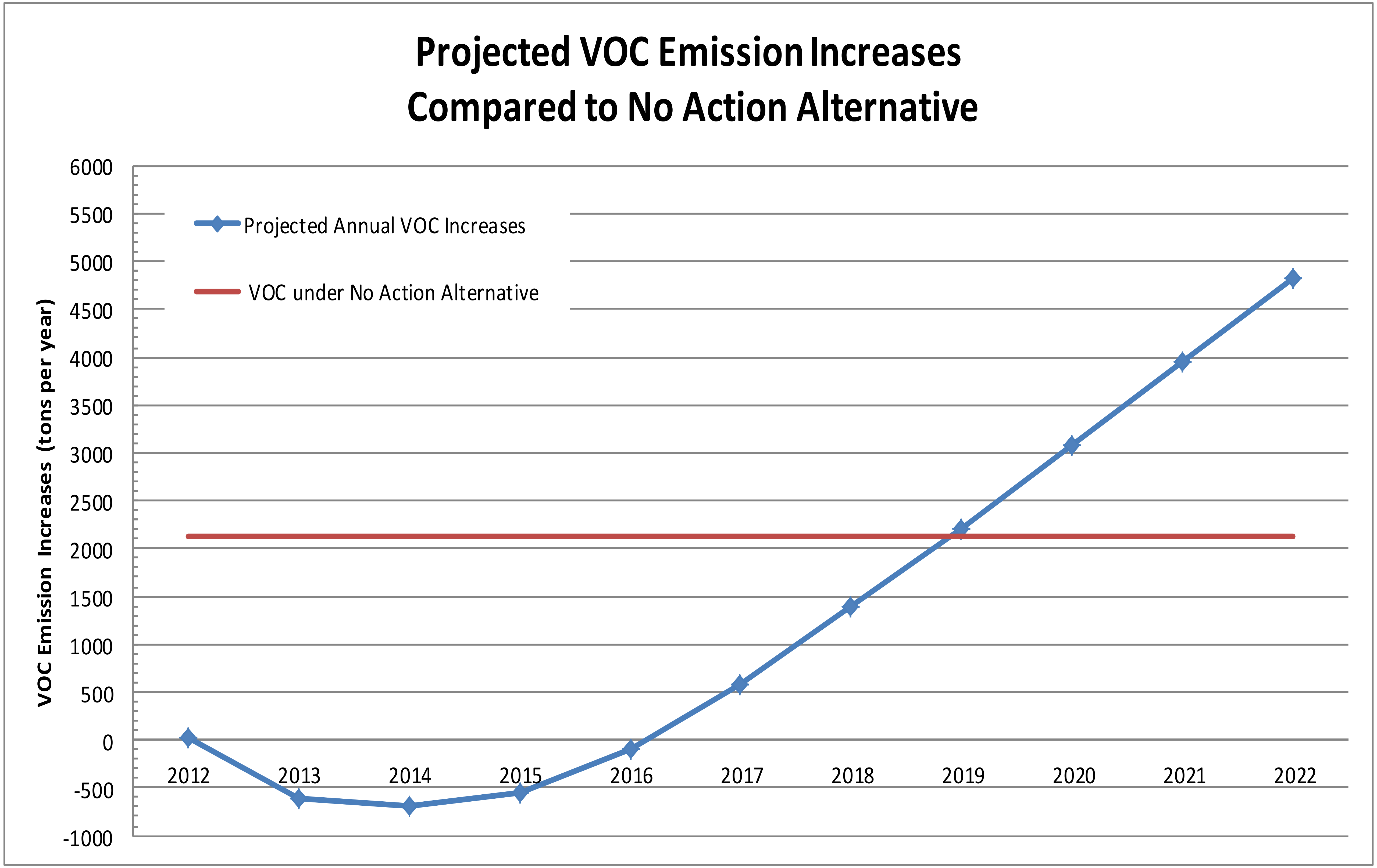
Monument Butte

Projected NOx Emission Increases Compared to No Action Alternative

FIGURE
6-1



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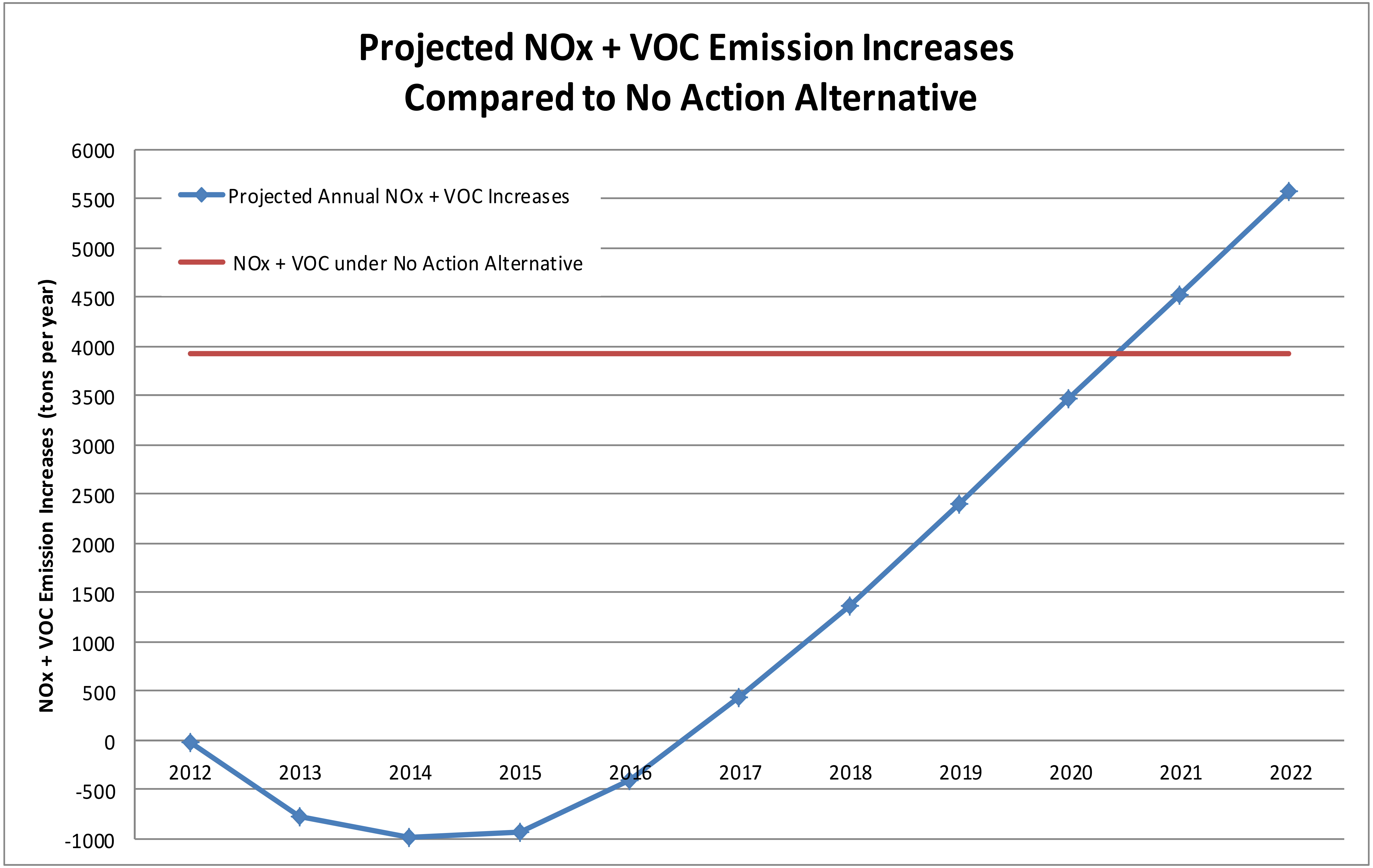
Projected VOC
Emission Increases Compared to No Action Alternative

FIGURE
6-2



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Monument Butte

Projected NOx + VOC
Emission Increases Compared to No Action Alternative

FIGURE
6-3

7 NEAR FIELD IMPACT EVALUATION

7.1 Construction and Development Emission Impact Results

The construction and development impact modeling scenario includes construction of well pads, drilling of wells, and developing wells on well pad sites located in close proximity to operating wells. Therefore, even though the scenario is called "construction and development", there are operating wells included in the modeling assessment. The construction and development model input and output files (electronic versions) are included in Appendix F. Table 7-1 shows the maximum impact for PM_{10} and $PM_{2.5}$. For PM_{10}, the 24-hour impact value is the high, second high modeled impact across all receptors and from all five years of meteorological data. The $PM_{2.5}$ annual impact value is the highest annual concentration across all receptors for any of the five years of meteorological data modeled. The $PM_{2.5}$ 24-hour impact value is the average of the eighth-high values from each of the modeled meteorological years. As discussed in Section 5, only one modeling scenario, the Proposed Action (Alternative A) was modeled for construction and development as the other Alternatives will have the same near field impact.

Table 7-1
Maximum Potential Construction and Development Impacts

Pollutant	Averaging Period	Ambient Air Concentration (µg/m^3)					
		Year of Maximum Impact	Location of Maximum Impact	Modeled Impact	Background	Total	NAAQS
PM_{10}	24-hour	2007	100 m west of pad construction	72.5	18.7	91.2	150
$PM_{2.5}$	24-hour	NA	200 m SE of pad construction	14.3	19.7	34.0	35
	Annual	2005	100 m east of producing wells	1.4	6.6	8.0	12

7.2 Operations Impact Results

The operations impact modeling scenario includes operations of oil and gas wells and infrastructure sources (e.g., compressor stations, gas processing plants, etc.) located in close proximity. The maximum impact of criteria pollutants for the Operations modeling scenarios occurred under the Alternative A modeling scenarios. All of the results in Table 7-2 are from the oil well modeling scenario as that scenario had greater impacts than the gas well modeling scenario except for 1-hour CO which is from the gas well modeling scenario. The maximum impacts and location of those impacts are shown in Table 7-2. To determine whether impacts could be greater for Alternative C than for Alternative A due to the turbine generator emissions at the proposed substations, Alternative C was also modeled for the Operations scenario. The maximum impacts occurred when there were no turbine generators, or Alternative A. The impact of the turbine generators of Alternative C is less than the impact of other compressor engines and well operations of Alternative A. The modeling runs demonstrating this are included in Appendix F and the results shown in Table 7-3. All of the results shown in Table 7-3 are from the oil well scenario.

For CO, the 1-hour and 8-hour impact value is the high second high modeled impact across all receptors and from all five years of meteorological data. The NO_2 annual impact value is the highest annual concentration across all receptors for any of the five years of meteorological data modeled. The NO_2 1-hour impact value is the average of the eighth-high values from each of the modeled meteorological years. The 1-hour SO_2 impact value is the average of the fourth-high values from each of the modeled meteorological years. The 3-hour SO_2 value is the high second high modeled impact across all receptors and from all five years of meteorological data.

Table 7-2
Maximum Potential Operations Impacts – Alternative A

Pollutant	Averaging Period	Ambient Air Concentration (µg/m^3)					
		Year of Maximum Impact	Location of Maximum Impact	Modeled Impact	Background	Total	NAAQS
CO	1-hour	2007	140 m NE of compressor station	276	2,641	2,917	40,000
	8-hour	2009	100 m east of GOSP	137	1,657	1,794	10,000
NO_2	1-hour	NA	100 m east of producing wells	106.9 [a]	65.7	172.6	188
	Annual	2005	100 m east of producing wells	16.5	8.8	25.3	100
SO_2	1-hour	NA	100 m east of GOSP	0.7	20.1	20.8	196
	3-hour	2006	100 m south of GOSP	0.6	14.3	14.9	1,300

[a] Assumes NO to NO_2 conversion of 80%

Table 7-3
Maximum Potential Operations Impacts – Alternative C

Pollutant	Averaging Period	Ambient Air Concentration (µg/m³)					
		Year of Maximum Impact	Location of Maximum Impact	Modeled Impact	Background	Total	NAAQS
CO	1-hour	2007	100 m south of GOSP	139	2,641	2,780	40,000
	8-hour	2009	100 m east of GOSP	80	1,657	1,737	10,000
NO_2	1-hour	NA	100 m south of GOSP	89.5 [a]	65.7	155.2	188
	Annual	2008	100 m south of GOSP	6.8	8.8	15.6	100
SO_2	1-hour	NA	100 m south of GOSP	0.6	20.1	20.7	196
	3-hour	2006	100 m south of GOSP	0.5	14.3	14.8	1,300

[a] Assumes NO to NO_2 conversion of 80%

7.3 Operations Hazardous Air Pollutant Impacts

The maximum impact of HAPs for the Operations modeling scenarios occurred under the Alternative A modeling scenario. Modeled results were compared to the Utah toxic screening levels, and the acute, chronic, and carcinogenic thresholds listed in Section 3.0 for each HAP of interest. Short-term impacts from HAP exposure were assessed by comparing one-hour average impacts to the HAP-specific acute REL (reference exposure level) and annual average impacts to the HAP-specific RfC (reference concentration for continuous inhalation exposure). If impacts are less than the REL and RfC, no short or long long-term non-carcinogenic adverse health effects are expected.

To assess potential carcinogenic impacts, the modeled annual average concentration is multiplied by a HAP specific unit risk factor to estimate the probability of contracting cancer if a person was exposed continuously to the modeled concentration. The unit risk factor is an upper-bound estimate of the probability of one additional person contracting cancer based on continuous exposure to 1-ug/m^3 of the substance over a 70-year lifetime. The risk from long-term exposure to carcinogenic HAP emissions is assessed by comparison to the generally acceptable risk range of one additional cancer per one million exposed persons (1 x 10^{-6}) to one additional cancer per ten thousand exposed persons (1 x 10^{-4}) or 100 in a million (USEPA 1993).

Since the URFs are based on 70-year exposure, adjustment factors are needed to adjust for maximum exposure durations associated with the project being evaluated. Cancer risk was estimated for two exposure scenarios: the most likely exposure (MLE) that individuals will experience, and the maximally exposed individual (MEI) as described in Section 3.4.

Table 7-4 presents the modeled non-carcinogenic impact results compared to the State of Utah TSLs for averaging periods of 1-hour (short-term). None of the HAPs exceed Utah TSLs. Table 7-5 presents the results compared to RELs and RfCs and none of the impacts exceed the RELs or RfCs.

Table 7-4
Maximum Utah Toxic Screening Level (TSL) Impacts

Pollutant and Averaging Time	Modeled Maximum Impact (μg/m³)	Maximum Impact Year	Toxic Screening Levels [b] (μg/m³)
Acrolein (1-hour)	1.50	2006	23
Benzene [a] (24-hour)	5.55	2005	18
Formaldehyde (1-hour)	12.32	2007	37

[a] The TSL for benzene is a 24-hour average, but the 1-hour concentration is conservatively compared to the TSL.

Table 7-5
Maximum Non-Carcinogenic REL and RfC Impacts

HAP	Modeled Maximum 1-Hour Impact (μg/m³)	Maximum Impact Year	REL (μg/m³)	Modeled Maximum Annual Impact (μg/m³)	Maximum Impact Year	RfC (μg/m³)
Acrolein	1.50	2006	2.50	0.18	2006	0.35
Benzene	5.55	2005	1,300	0.30	2005	30
Formaldehyde	12.32	2007	55	1.27	2006	9.8

Table 7-6 presents the unit risk factor, exposure adjustment factor, and the estimated cancer risk for the MLE and MEI exposure scenarios for the Proposed Action. A range of unit risk factors is available for benzene, and that range is shown in the table. All estimated risks are within the acceptable range of 1 to 100 in a million.

Table 7-6
Maximum Potential Carcinogenic HAP Risk

Exposure Scenario	HAP	Unit Risk Factor (1/µg/m³)	Exposure Adjustment Factor	Modeled Annual Impact (µg/m³)	Cancer Risk
MLE	Benzene	2.2×10^{-06} to 7.8×10^{-06}	0.095	0.30	6.2×10^{-08} to 2.2×10^{-07}
	Formaldehyde	1.3×10^{-05}	0.095	1.27	1.6×10^{-06}
	TOTAL MLE RISK				**1.8×10^{-06}**
MEI	Benzene	2.2×10^{-06} to 7.8×10^{-06}	0.571	0.30	3.8×10^{-07} to 1.3×10^{-06}
	Formaldehyde	1.3×10^{-05}	0.571	1.27	9.4×10^{-06}
	TOTAL MEI RISK				**1.1×10^{-05}**

There is uncertainty associated with adding cancer risk values from different chemicals together, although it is commonly done for carcinogens having similar modes of action or target organs. Both formaldehyde and benzene have been linked to possibly causing leukemia under prolonged and extremely high concentrations (CDC 2013 and NCI 2013). Therefore the cancer risk from benzene and formaldehyde were added together.

8 FAR FIELD IMPACT EVALUATION

The far field analysis is focused on evaluating air quality related values (AQRVs) at distant Class I areas, sensitive Class II areas, and sensitive lakes as discussed in Section 5. The AQRVs examined were PSD increments, regional haze, change in acid neutralization capacity (ANC), and acid deposition (sulfur and nitrogen). The CALPUFF modeling system was used to evaluate far field impacts. The model input and output files are included in Appendix F. As discussed in Section 5, only Alternative A was modeled to assess far field impacts as all the other Alternatives will have lower impacts than the modeled Alternative.

8.1 PSD Increments

Although impacts of the Proposed Action are compared to PSD increments, all comparisons with PSD increments are intended as a point of reference only and do not represent a regulatory PSD increment consumption analysis. PSD increment consumption analyses are applied to large industrial sources during the permitting process, and are the responsibility of the State of Utah with USEPA oversight. The Proposed Action is not subject to the PSD program.

Table 8-1 shows the modeled impacts at the nearest Class I areas and sensitive Class II areas compared to the Class I and II increments. All of the impacts are less than the Class I increments.

8.2 Regional Haze

To assess potential regional haze impacts, the modeled change in light extinction (b_{ext}) was compared to the 5 percent (0.5 deciviews or 0.5 dV) and 10 percent (1.0 dV) change in light extinction thresholds. The number of days exceeding the thresholds were calculated as well as the eighth-high (98^{th} percentile) change in b_{ext}. The results for the nearest Class I and II areas are shown in Table 8-2.

Table 8-1
Maximum Impacts at Class I and Sensitive Class II Areas Compared to PSD Increments

Class I and Sensitive Class II Areas	NO_2 Annual (ug/m^3)	PM_{10} Annual (ug/m^3)	PM_{10} 24-hr (ug/m^3)	$PM_{2.5}$ Annual (ug/m^3)	$PM_{2.5}$ 24-hr (ug/m^3)	SO_2 3-hr (ug/m^3)	SO_2 24-hr (ug/m^3)	SO_2 Annual (ug/m^3)
PSD Class I Increments	**2.5**	**4**	**8**	**2**	**1**	**25**	**5**	**2**
National Park Service (NPS) Class I Areas								
Arches National Park	0.0016	0.022	0.513	0.0047	0.110	0.005	0.0008	0.00003
NPS Class II Areas								
Dinosaur National Monument	0.0491	0.2334	4.55	0.0496	0.966	0.1053	0.0135	0.0005
U.S. Forest Service Class II Areas								
Flaming Gorge National Recreation Area	0.0029	0.067	0.549	0.0142	0.117	0.011	0.0014	0.00011
High Uintas Wilderness Area	0.0058	0.0913	0.779	0.0194	0.1655	0.021	0.0028	0.00016
U.S. Fish and Wildlife Service Class II Areas								
Browns Park National Wildlife Refuge	0.0046	0.0614	0.583	0.0130	0.1236	0.0130	0.0017	0.00011
PSD Class II Increments	**25**	**17**	**30**	**9**	**4**	**512**	**91**	**20**

Table 8-2
Regional Haze Impacts at Class I and Sensitive Class II Areas

Class I and Sensitive Class II Areas	Number of Days > 0.5 dV Change	Number of Days >1.0 dV Change	Max Change in b_{ext} (dV)	Eighth-High Change in b_{ext} (dV)
National Park Service (NPS) Class I Areas				
Arches National Park	17	1	2.01	0.75
NPS Class II Areas				
Dinosaur National Monument	131	89	8.12	3.20
U.S. Forest Service Class II Areas				
Flaming Gorge National Recreation Area	64	27	2.22	1.60
High Uintas Wilderness Area	85	52	3.32	2.22
U.S. Fish and Wildlife Service Class II Areas				
Browns Park National Wildlife Refuge	63	16	1.73	1.11

All the nearest areas analyzed have multiple days with a change in b_{ext} greater than 0.5 dV, and a single day with a maximum change greater than 1.0 dV at Arches National Park (although the

98th percentile or 8th-high change is less than 1.0 dV). The Federal Land Managers have not promulgated thresholds of concern for sensitive Class II areas.

8.3 Acid Deposition Impacts

To assess potential acid deposition impacts at Class I and sensitive Class II areas, sulfur and nitrogen deposition was compared to the 3 kilogram per hectare per year (kg/ha-yr) threshold for nitrogen and 5 kg/ha-yr for sulfur deposition and to the Deposition Analysis Threshold (DAT) of 0.005 kg/ha-yr for both nitrogen and sulfur species promulgated by the Federal Land Managers (FLAG 2010) for western areas. The DATs do not represent an adverse impact threshold, but rather an estimate of the naturally occurring deposition that occurred prior to any anthropogenic influences. The DATs are levels below which estimated impacts from a proposed new or modified source are considered negligible. In cases where a source's impact equals or exceeds the DAT, the NPS/FWS will make a project specific assessment of whether the projected increase in deposition would likely result in an "adverse impact" on resources considering existing AQRV conditions, the magnitude of the expected increase, and other factors. The results are shown in Table 8-3. All of the deposition rates are much less than the 3 and 5 kg/ha-year thresholds. The DAT was exceeded at the closest Class I and Class II areas for nitrogen deposition, but not sulfur deposition.

Table 8-3
Acid Deposition Impacts at Class I and Sensitive Class II Areas

Class I and Sensitive Class II Areas	Nitrogen Deposition (kg/ha-yr)	Sulfur Deposition (kg/ha-yr)
National Park Service (NPS) Class I Areas		
Arches National Park	0.0028	0.00002
NPS Class II Areas		
Dinosaur National Monument	0.0279	0.00020
U.S. Forest Service Class II Areas		
Flaming Gorge National Recreation Area	0.0147	0.00008
High Uintas Wilderness Area	0.0150	0.00007
U.S. Fish and Wildlife Service Class II Areas		
Browns Park National Wildlife Refuge	0.0092	0.00006

8.4 Sensitive Lake Impacts

To assess potential impact on sensitive lakes, the change in ANC was calculated from the CALPUFF output for sulfur and nitrogen deposition to estimate potential hydrogen ion deposition). The results are shown in Table 8-4. For lakes with background ANC greater than 25 micro equivalents per liter (µeq/l), all of the ANC changes are less than the 10 percent threshold of concern. For lakes with background ANC less than 25 µeq/l, the changes (H_{dep} in terms of ueq/l) are all much less than the 1 µeq/l change threshold.

Table 8-4
Acid Deposition Impacts at Sensitive Lakes

		Back-ground ANC (µeq/l)	Water-shed Area (ha)	Annual Ave Precip (m)	ANC(o) (eq)	H_{dep} eq	Percent ANC Change Hdep/ANC(o) (%)	H_{dep} (µeq/l)
Eagles Nest Wilderness								
	Booth Lake	86.4	54.0	0.29	9190.2	9.98	0.11	0.06
	Upper Willow Lake	133.2	124.0	0.29	32549.4	20.46	0.06	0.06
Flat Tops Wilderness								
	Ned Wilson Lake	39.4	49.2	0.26	3312.0	1.51	0.05	0.01
	Trappers Lake [a]	659.4	--	0.26	--	--	--	
	Upper Ned Wilson Lake	12.9	3.1	0.26	68.7	0.92	1.35	0.11
Maroon Bells-Snowmass Wilderness								
	Avalanche Lake	171.0	358.0	0.24	96575.6	55.93	0.06	0.07
	Capitol Lake	186.6	139.0	0.24	40918.0	22.16	0.05	0.07
	Moon Lake (Upper)	54.3	117.0	0.24	10018.8	18.52	0.18	0.07
Mount Zirkel Wilderness								
	Lake Elbert	53.8	101.0	0.42	15476.4	22.21	0.14	0.05
	Summit Lake	48.0	7.8	0.42	1061.9	1.65	0.16	0.05
Weminuche Wilderness								
	Big Eldorado Lake	20.4	115.0	0.47	7430.2	5.78	0.08	0.01
	Little Eldorado Lake	-3.3	48.7	0.47	-509.3	2.46	-0.48	0.01
	Lower Sunlight Lake	85.0	96.6	0.47	26030.9	4.38	0.02	0.01
	Upper Grizzly Lake	29.9	30.0	0.47	2840.5	1.96	0.07	0.01
	Upper Sunlight Lake	28.0	76.9	0.47	6823.0	3.45	0.05	0.01
	White Dome Lake	2.1	38.8	0.47	253.3	1.95	0.77	0.01
West Elk Wilderness								
	South Golden Lake	112.6	73.0	0.29	15946.8	7.40	0.05	0.03
High Uintas Wilderness								
	Dean Lake	51.4	117.0	0.41	16569.3	72.49	0.44	0.15
	Fish Lake [a]	104.5	--	0.41	--	--	--	
Raggeds Wilderness								
	Deep Creek Lake	40.0	525.0	0.28	39811.9	70.54	0.18	0.05
	Island Lake [b]	--	--	0.28	--	--	--	--

[a] For Trappers and Fish Lakes, ANC calculations could not be made because the watershed area was not available from the USFS.
[b] For Island Lake, ANC calculations could not be made because there was no data in the USFS database.

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APPENDIX A

ALTERNATIVE A -- PROPOSED ACTION ULTIMATE DEVELOPMENT EMISSIONS

APPENDIX A-1
PROPOSED ACTION OIL WELL EMISSIONS

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Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative A - Oil Wells [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	6.9	2.6	0.6	0.0002	5.8	1.4
	Drilling	83.9	83.9	4.7	0.2	147.4	16.0
	Completion	38.1	18.9	6.8	0.023	265.9	28.1
	Interim Reclamation	0.6	0.7	0.05	0.0006	3.2	0.3
	Wind Erosion	---	---	---	---	1.1	0.2
Wellsite Production Emissions	Pump Unit Engines	1,465.0	1,999.9	396.6	1.9	159.7	159.7
	Production Heaters	327.0	274.6	18.0	2.0	24.8	24.8
	Wellsite Tanks	---	---	1,714.2	---	---	---
	Pneumatics	---	---	397.9	---	---	---
	Fugitives	---	---	1,198.0	---	---	---
	Wellsite Truck Loading	---	---	203.7	---	---	---
	Wellsite Flares	1.7	9.4	---	---	---	---
	Operations Vehicle	15.9	6.8	0.6	0.010	385.8	39.6
Water Treatment Facilities	Water Treatment Oil Tanks	---	---	281.5	---	---	---
	Water Treatment Fugitives	---	---	12.0	---	---	---
	Water Treatment Generator	244.2	488.3	170.9	0.6	19.3	19.3
Gas and Oil Separation Plants	GOSP Heaters	170.0	142.8	9.4	1.0	12.9	12.9
	GOSP Fugitives	---	---	139.3	---	---	---
	GOSP Generators	225.4	450.7	157.8	0.5	17.9	17.9
	GOSP Flare	10.7	58.3	---	---	---	---
	GOSP Truck Loadout and Vehicle Traffic	15.3	2.9	46.8	0.01	326.5	33.6
Compressor Station Emissions	Compressor Station Engines	309.0	618.0	216.3	0.7	11.2	11.2
	Compressor Station Tanks	---	---	5.2	---	---	---
	Compressor Station Dehydrator	---	---	46.8	---	---	---
	Compressor Station Truck Loading and Vehicle Traffic	0.3	0.1	11.1	0.0	5.2	0.5
	Compressor Station Dehydrator Heater	2.6	2.2	0.1	0.0	0.2	0.2
	Compressor Station Flare	3.6	19.4	---	---	---	---
	Compressor Station Fugitives	---	---	12.1	---	---	---
	Total Emissions	**2,920.2**	**4,179.6**	**5,050.3**	**6.9**	**1,386.7**	**365.8**

a Emissions in summary tables may vary slightly due to rounding differences.

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Date: 7/15/2013

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b]					Total
	Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
Criteria Pollutants & VOC						
NO_X	6.9	83.9	38.1	0.6	---	129.6
CO	2.6	83.9	18.9	0.7	---	106.0
VOC	0.6	4.7	6.8	0.05	---	12.1
SO_2	0.0002	0.2	0.02	0.0006	---	0.2
PM_{10}	5.8	147.4	265.9	3.2	1.1	423.3
$PM_{2.5}$	1.4	16.0	28.1	0.3	0.2	46.0
Hazardous Air Pollutants						
Benzene	---	0.07	0.012	---	---	0.084
Toluene	---	0.03	0.005	---	---	0.031
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.02	0.0018	---	---	0.020
n-Hexane	---	---	0.095	---	---	0.095
Formaldehyde	---	0.007	0.0006	---	---	0.0080
Acetaldehyde	---	0.002	0.00020	---	---	0.0026
Acrolein	---	0.0007	0.00006	---	---	0.00080
Naphthalene	---	0.012	0.0010	---	---	0.013
POM 2	---	0.007	0.0006	---	---	0.0078
POM 5	---	0.00006	0.000005	---	---	0.000061
POM 6	---	0.0002	0.000019	---	---	0.00024
POM 7	---	0.0001	0.000012	---	---	0.00016
Greenhouses Gases						
CO_2	171.7	15,975	2,565	63	---	18,776
CH_4	0.001	0.64	18.17	0.002	---	18.81
N_2O	0.0003	0.13	0.02	0.0007	---	0.15
CO_2e	171.8	16,029	2,954	64	---	19,218

a Assumes maximum development scenario of 204 wells in one year
b Emissions in summary tables may vary slightly due to rounding differences.
c Total drilling emissions includes Tier IV drill rig engines

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Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

Total Project Production Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]								
	Well Pump Engines	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Wellsite Flares	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	1465.0	327.0	---	---	---	---	1.7	15.9	1,809.7
CO	1999.9	274.6	---	---	---	---	9.4	6.8	2,290.7
VOC	396.6	18.0	1714.2	1198.0	203.7	397.9	---	0.6	3,929.0
SO_2	1.9	2.0	---	---	---	---	---	0.010	3.9
PM_{10}	159.7	24.8	---	---	---	---	---	385.8	570.3
$PM_{2.5}$	159.7	24.8	---	---	---	---	---	39.6	224.1
Hazardous Air Pollutants									
Benzene	6.41	0.0069	5.45	3.31	0.65	0.42	---	---	16.25
Toluene	3.18	0.011	5.03	2.97	0.60	0.22	---	---	12.01
Ethylbenzene	0.36	---	0.28	0.16	0.03	---	---	---	0.83
Xylene	0.89	---	1.61	0.92	0.19	0.022	---	---	3.63
n-Hexane	1.47	5.89	85.79	52.55	10.19	7.35	---	---	163.24
Formaldehyde	182.44	0.25	---	---	---	---	---	---	182.68
Acetaldehyde	25.65	---	---	---	---	---	---	---	25.65
Acrolein	25.71	---	---	---	---	---	---	---	25.71
Methanol	8.20	---	---	---	---	---	---	---	8.20
1,1,2,2-Tetrachloroethane	0.22	---	---	---	---	---	---	---	0.22
1,1,2-Trichloroethane	0.17	---	---	---	---	---	---	---	0.17
1,3-Dichloropropene	0.14	---	---	---	---	---	---	---	0.14
1,3-Butadiene	2.71	---	---	---	---	---	---	---	2.71
2,2,4-Trimethylpentane	2.80	---	---	---	---	---	---	---	2.80
Biphenyl	0.013	---	---	---	---	---	---	---	0.013
Carbon Tetrachloride	0.20	---	---	---	---	---	---	---	0.20
Chlorobenzene	0.15	---	---	---	---	---	---	---	0.15
Chloroform	0.16	---	---	---	---	---	---	---	0.16
Dichlorobenzene	---	0.0039	---	---	---	---	---	---	0.0039
Ethylene Dibromide	0.24	---	---	---	---	---	---	---	0.24
Methylene Chloride	0.49	---	---	---	---	---	---	---	0.49
Naphthalene	0.32	0.0020	---	---	---	---	---	---	0.32
Phenol	0.14	---	---	---	---	---	---	---	0.14
Styrene	0.18	---	---	---	---	---	---	---	0.18
Vinyl Chloride	0.082	---	---	---	---	---	---	---	0.082
PAH -POM 1	0.44	---	---	---	---	---	---	---	0.44
POM 2	0.11	0.00019	---	---	---	---	---	---	0.11
POM 3	---	0.000052	---	---	---	---	---	---	0.000052
POM 4	---	0.0000059	---	---	---	---	---	---	0.0000059
POM 5	0.000019	0.0000078	---	---	---	---	---	---	0.000027
POM 6	0.0012	0.000024	---	---	---	---	---	---	0.0012
POM 7	0.0022	0.0000059	---	---	---	---	---	---	0.0022
Greenhouse Gases									
CO_2	386,316	389,813	22.8	16.9	1.58	12.29	3,257	1,391	780,830
CH_4	7.29	7.35	410.5	1929.1	48.78	1,403	10.0	0.0155	3,816
N_2O	0.73	0.74	---	---	---	---	0.0033	0.0035	1.47
CO_2e	386,694	390,195	8,643	40,529	1,026	29,474	3,468	1,392	861,421

a Assumes maximum development scenario of 3250 wells

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

Total Project Infrastructure Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]									
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Generators	Central Facility Flares	Dehydrators	Compressor Engines	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC										
NO_X	172.6	---	---	---	469.5	14.3	---	309.0	15.6	981.0
CO	145.0	---	---	---	939.1	77.8	---	618.0	3.0	1,782.8
VOC	9.5	286.7	163.4	57.4	328.7	---	46.8	216.3	0.5	1,109.2
SO_2	1.0	---	---	---	1.1	---	---	0.7	0.01	2.8
PM_{10}	13.1	---	---	---	37.2	---	---	11.15	331.7	393.2
$PM_{2.5}$	13.1	---	---	---	37.2	---	---	11.15	34.2	95.6
Hazardous Air Pollutants										
Benzene	0.004	0.95	0.41	0.26	1.51	---	2.24	0.25	---	5.61
Toluene	0.006	0.91	0.36	0.32	0.53	---	1.58	0.23	---	3.93
Ethylbenzene	---	0.050	0.018	0.015	0.024	---	---	0.0223	---	0.13
Xylene	---	0.29	0.11	0.11	0.19	---	0.28	0.103	---	1.08
n-Hexane	3.11	14.22	6.30	2.60	---	---	1.36	0.62	---	28.22
Formaldehyde	0.13	---	---	---	19.65	---	---	29.60	---	49.38
Acetaldehyde	---	---	---	---	2.67	---	---	4.69	---	7.36
Acrolein	---	---	---	---	2.52	---	---	2.88	---	5.40
Methanol	---	---	---	---	2.93	---	---	1.40	---	4.33
1,1,2,2-Tetrachloroethane	---	---	---	---	0.024	---	---	0.0224	---	0.047
1,1,2-Trichloroethane	---	---	---	---	0.015	---	---	0.0178	---	0.032
1,3-Dichloropropene	---	---	---	---	0.012	---	---	0.0148	---	0.027
1,3-Butadiene	---	---	---	---	0.64	---	---	0.150	---	0.79
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	0.140	---	0.14
Biphenyl	---	---	---	---	---	---	---	0.119	---	0.12
Carbon Tetrachloride	---	---	---	---	0.017	---	---	0.0206	---	0.038
Chlorobenzene	---	---	---	---	0.012	---	---	0.0170	---	0.029
Chloroform	---	---	---	---	0.013	---	---	0.0160	---	0.029
Dichlorobenzene	0.0021	---	---	---	---	---	---	---	---	0.0021
Ethylene Dibromide	---	---	---	---	0.020	---	---	0.0248	---	0.045
Methylene Chloride	---	---	---	---	0.039	---	---	0.0112	---	0.05
Naphthalene	0.0011	---	---	---	0.093	---	---	0.042	---	0.14
Phenol	---	---	---	---	---	---	---	0.0135	---	0.013
Styrene	---	---	---	---	0.011	---	---	0.0132	---	0.025
Tetrachloroethane	---	---	---	---	---	---	---	0.00139	---	0.0014
Vinyl Chloride	---	---	---	---	0.007	---	---	0.0084	---	0.015
PAH -POM 1	---	---	---	---	0.14	---	---	0.015	---	0.15
POM 2	0.00010	---	---	---	---	---	---	0.033	---	0.033
POM 3	0.000028	---	---	---	---	---	---	---	---	0.000028
POM 4	0.0000031	---	---	---	---	---	---	---	---	0.0000031
POM 5	0.0000041	---	---	---	---	---	---	---	---	0.0000041
POM 6	0.000012	---	---	---	---	---	---	0.000093	---	0.00011
POM 7	0.000003	---	---	---	---	---	---	0.00039	---	0.00039
Greenhouse Gases										
CO_2	205,812	23.25	2.4	2.607	224,045	35,625	---	131,064	1,315	597,890
CH_4	3.88	72.40	278.1	21.74	4.23	228	57.40	2.47	0.008	667.8
N_2O	0.39	---	---	---	0.42	0.05	---	0.25	0.001	1.1
CO_2e	206,013	1,544	5,843	459	224,265	40,418	1,206	131,193	1,316	612,256

a Assumes maximum development scenario of 3250 wells

b Emissions in summary tables may vary slightly due to rounding differences.

KLEINFELDER Bright People. Right Solutions.	Project: GMBU - Alternative A - Oil Wells Date: 7/15/2013

Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	129.6	1,809.7	981.0	2,920.2
CO	106.0	2,290.7	1,782.8	4,179.6
VOC	12.1	3,929.0	1,109.2	5,050.3
SO_2	0.2	3.9	2.8	6.9
PM_{10}	423.3	570.3	393.2	1,386.7
$PM_{2.5}$	46.0	224.1	95.6	365.8
Hazardous Air Pollutants				
Benzene	0.084	16.25	5.61	21.95
Toluene	0.031	12.01	3.93	15.98
Ethylbenzene	---	0.83	0.13	0.96
Xylene	0.020	3.63	1.08	4.73
n-Hexane	0.095	163.24	28.22	191.55
Formaldehyde	0.0080	182.68	49.38	232.07
Acetaldehyde	0.0026	25.65	7.36	33.01
Acrolein	0.00080	25.71	5.40	31.12
Methanol	---	8.20	4.33	12.53
1,1,2,2-Tetrachloroethane	---	0.219	0.047	0.27
1,1,2-Trichloroethane	---	0.174	0.032	0.21
1,3-Dichloropropene	---	0.145	0.027	0.17
1,3-Butadiene	---	2.71	0.79	3.50
2,2,4-Trimethylpentane	---	2.80	0.14	2.94
Biphenyl	---	0.013	0.12	0.13
Carbon Tetrachloride	---	0.201	0.038	0.24
Chlorobenzene	---	0.147	0.029	0.18
Chloroform	---	0.156	0.029	0.18
Dichlorobenzene	---	0.0039	0.0021	0.0060
Ethylene Dibromide	---	0.243	0.045	0.29
Methylene Chloride	---	0.49	0.051	0.54
Naphthalene	0.0132	0.32	0.14	0.47
Phenol	---	0.139	0.013	0.15
Styrene	---	0.181	0.025	0.21
Vinyl Chloride	---	0.082	0.015	0.10
(PAH) POM 1	---	0.44	0.15	0.59
POM 2	0.0078	0.109	0.033	0.15
POM 3	---	0.000052	0.000028	0.000080
POM 4	---	0.0000059	0.0000031	0.0000090
POM 5	0.000061	0.000027	0.0000041	0.000092
POM 6	0.000240	0.00118	0.00011	0.0015
POM 7	0.000155	0.00223	0.0004	0.0028
Total HAPs	0.26	446.77	107.16	554.19
Greenhouse Gases				
CO_2	18,776	780,830	597,890	1,397,495
CH_4	18.81	3,816	668	4,502.6
N_2O	0.154	1.47	1.11	2.73
CO_2e	19218	861,421	612,256	1,492,896

a Emissions for Peak Field Development
b Emissions in summary tables may vary slightly due to rounding differences.

1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	3	days per well pad
	12	hours per day
	36	hours per well pad
Annual amount of well pads	47	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = 5.7 * (soil silt content %)$^{1.2}$ * (soil moisture content %)$^{-1.3}$* Control Efficiency
Emissions (PM_{15} lbs/hr) = 1.0 * (soil silt content %)$^{1.5}$ * (soil moisture content %)$^{-1.4}$ * Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment
Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.035	1.67	1.97	0.035	1.67	3.33
PM_{15}	0.50	0.009	0.42	0.50	0.009	0.42	0.85
PM_{10}	0.38	0.007	0.32	0.38	0.007	0.32	0.64
$PM_{2.5}$	0.21	0.004	0.18	0.21	0.004	0.18	0.35

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.
b Assumes maximum development scenario

2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	3	day grading per well pad
	12	hours/day
	36	hours per well pad
Deep gas well pads	0	well pads/year
Oil well pads	47	well pads/year
Distance graded - Oil well	1.19	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Oil wells			Total Emissions
	lbs/well	lbs/hr/well pad	tons/well pad	tons/year[a]
TSP	3.21	0.09	0.0016	0.075
PM_{15}	1.53	0.043	0.00077	0.036
PM_{10}	0.92	0.026	0.00046	0.022
$PM_{2.5}$	0.10	0.003	0.000050	0.0023

a Assumes maximum development scenario

3. Road Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	4	days per mile
	12	hours per day
	0.19	miles of road per well pad
	9	hours per well pad road
Annual amount of well pads with roads	47	pads with roads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content }\%)^{1.2} * (\text{soil moisture content }\%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment
Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.009	0.41	1.97	0.009	0.41	0.83
PM_{15}	0.50	0.002	0.11	0.50	0.002	0.11	0.21
PM_{10}	0.38	0.002	0.08	0.38	0.002	0.08	0.16
$PM_{2.5}$	0.21	0.0009	0.04	0.21	0.001	0.04	0.087

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.
b Assumes maximum development scenario

4. Road Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	9	hours per well pad roads
Road construction grading distance	0.37	miles road per well pad
Annual well pads	47	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Roads			Total Emissions
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year**[a]
TSP	1.00	0.11	0.0005	0.024
PM_{15}	0.48	0.05	0.00024	0.011
PM_{10}	0.29	0.032	0.00014	0.0068
$PM_{2.5}$	0.03	0.003	0.000016	0.00073

a Assumes maximum development scenario

Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

5. Pipeline Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	10	days per mile
	12	hours per day
	0.19	miles of pipeline per well pad
	22	hours per well pad pipeline
Annual amount of well pads withpipeline	47	pads with pipeline/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content }\%)^{1.2} * (\text{soil moisture content }\%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.022	1.04	1.97	0.022	1.04	2.07
PM_{15}	0.50	0.006	0.26	0.50	0.006	0.26	0.53
PM_{10}	0.38	0.0042	0.20	0.38	0.0042	0.20	0.40
$PM_{2.5}$	0.21	0.0023	0.11	0.21	0.0023	0.11	0.22

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

6. Pipeline Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	22	hours per well pad pipeline
Pipeline construction grading distance	0.75	miles pipeline per well pad
Annual well pads	47	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Pipeline			Total Emissions
	lbs/well	lbs/hr/well pad	tons/well pad	tons/year[a]
TSP	2.00	0.09	0.0010	0.047
PM_{15}	0.96	0.043	0.00048	0.023
PM_{10}	0.58	0.026	0.00029	0.014
$PM_{2.5}$	0.06	0.0028	0.000031	0.0015

a Assumes maximum development scenario

KLEINFELDER	Project: GMBU - Alternative A - Oil Wells Date: 7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual
$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual
$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily
$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S) 5.1 AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles 19
Precipitation Days (P) 45 days per year (NCDC data for Ouray, UT 1955-2004)
W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily
$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles 6
Precipitation Days (P) 45 days per year
W = average weight in tons of vehicles traveling the road

Construction Emissions

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of pads per year	47	well pads/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-pad**	**ton/year-pad**	**ton/year**
PM_{10}	1.20	1.05	5.61	0.09	4.16
$PM_{2.5}$	0.12	0.11	0.56	0.009	0.42

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-pad**	**ton/year-pad**	**ton/year**
PM_{10}	0.015	0.014	0.023	0.00040	0.02
$PM_{2.5}$	0.0036	0.0035	0.0056	0.00010	0.005

Drilling - Oil Wells

Hours per day	24	hour/day
Days per oil well	6	day/well
Number of wells per year	204	wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	3
Light Trucks	8,000	5
Mean Vehicle Weight	25,000	---
Total Round Trips	---	11

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-well**	**ton/year-well**	**ton/year**
PM_{10}	1.32	1.16	11.29	0.71	145.36
$PM_{2.5}$	0.13	0.12	1.13	0.07	14.54

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-well**	**ton/year-well**	**ton/year**
PM_{10}	0.018	0.018	0.052	0.0036	0.74
$PM_{2.5}$	0.0045	0.0043	0.013	0.0009	0.18

Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365\text{-}p)/365$ Annual

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365\text{-}p)/365$ Annual

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Interim Reclamation

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of wells per year	47	wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	1.35	1.19	4.21	0.07	3.13
$PM_{2.5}$	0.14	0.12	0.42	0.007	0.31

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	0.019	0.019	0.020	0.00035	0.02
$PM_{2.5}$	0.0047	0.0046	0.0049	0.00009	0.004

Completion - Oil Well

Hours per day	24	hour/day
Days per oil well	7	day/well
Number of wells per year	204	wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	7
Haul Trucks	45,000	2
Light Trucks	8,000	7
Mean Vehicle Weight	28,813	---
Total Round Trips	---	16

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	1.41	1.23	17.50	1.29	262.95
$PM_{2.5}$	0.14	0.12	1.75	0.13	26.29

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	0.021	0.020	0.087	0.007	1.44
$PM_{2.5}$	0.0052	0.0050	0.021	0.0017	0.35

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	Paved Total tons/year	Total tons/year
PM_{10}	415.60	2.21	417.81
$PM_{2.5}$	41.56	0.54	42.10

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

8. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	377	acres total disturbance for roads and pipelines per year
	1,523,892	square meters total initial disturbance for roads and pipelines
	94	acres total disturbance for well pads per year
	380,404	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed (U_{10}^{+})	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\ U_{10}^{+}$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, P = 0 for $U^*< U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	2.14	0.00
PM_{10}	1.07	0.00
$PM_{2.5}$	0.16	0.00

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9. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction	3	days per well pad
Well pads per year	47	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.18	0.16
CO	1.98E-02	0.041	0.00074	7.26E-02	0.30	0.0054	0.34	0.29
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.021	0.018
SO_2	4.57E-05	0.000095	0.0000017	2.83E-05	0.00012	0.0000021	0.00021	0.00018
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00080	0.000014	0.010	0.008
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00074	0.000013	0.0092	0.008
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	6.67	0.12	20.61	17.44
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00086	0.000016	0.0010	0.0008
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00033	0.0000060	0.00036	0.0003
CO_2e [d]	---	13.95	0.25	---	6.79	0.12	20.75	17.55

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	47	new pads per year
Backhoe miles per pad	0.58	miles (Value assumed to be 1/4 of dozer or grader mileage)
Backhoe Hours	67.3	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer miles per pad	2.3	miles
Dozer Hours	67.3	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader miles per pad	2.3	miles
Motor Grader Hours	67.3	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horse Power} * \text{Hours} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)
Criteria Pollutants & VOC									
NOx	6.9	0.28	0.0094	8.38	1.48	0.050	8.38	2.52	0.085
CO	3.49	0.14	0.0047	2.7	0.48	0.016	2.70	0.81	0.027
VOC [b]	0.99	0.040	0.0013	0.68	0.12	0.0041	0.68	0.20	0.0069
PM_{10}	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
$PM_{2.5}$	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
Greenhouse Gases									
CO_2 [c]	188.2	7.59	0.26	188.2	33.31	1.12	188.2	56.59	1.91
CO_2e [e]	---	7.59	0.26	---	33.31	1.12	---	56.59	1.91

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC		
NOx	4.28	6.77
CO	1.43	2.26
VOC	0.36	0.58
PM_{10}	0.22	0.35
$PM_{2.5}$	0.22	0.35
Greenhouse Gases		
CO_2	97.50	154.26
CO_2e [e]	97.50	154.26

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor: 73.96 kg CO_2/mmBtu
393 hp-hr = mmBtu
188.2 g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

11. Drilling Tailpipe Emissions

Assumptions:

Number of oil wells drilled	204	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	144	hours per site (oil well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (oil well)
Number of Pickup Trips	5	trips/day-well (oil well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	**Heavy Haul Trucks-Oil Wells**			**Heavy Duty Pickups-Oil Wells**			**Total-Oil Wells** [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.033	7.39E-03	0.038	0.0028	0.50	7.35
CO	1.98E-02	0.12	0.0089	7.26E-02	0.38	0.027	0.50	7.33
VOC [c]	3.16E-03	0.020	0.0014	3.54E-03	0.018	0.0013	0.038	0.56
SO_2	4.57E-05	0.00028	0.000020	2.83E-05	0.00015	0.000011	0.00043	0.0063
PM_{10}	4.22E-03	0.026	0.0019	1.94E-04	0.0010	0.000072	0.027	0.40
$PM_{2.5}$	4.09E-03	0.025	0.0018	1.79E-04	0.00093	0.000067	0.026	0.39
Greenhouse Gases								
CO_2	6.73E+00	41.83	3.01	1.61E+00	8.34	0.60	50.17	736.83
CH_4	6.56E-05	0.00041	0.000029	2.08E-04	0.0011	0.000078	0.0015	0.022
N_2O	1.20E-05	0.000075	0.0000054	8.05E-05	0.00042	0.000030	0.00049	0.0072
CO_2e [d]	---	41.86	3.01	---	8.49	0.61	50.35	739.53

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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12. Completion Tailpipe Emissions

Assumptions:

Number of oil wells	204	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	168	hours per site (oil well)
Number of Heavy Diesel Truck Trips	9	trips/day-well (oil well)
Number of Pickup Trips	7	trips/day-well (oil well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks-Oil Wells			Heavy Duty Pickups-Oil Wells			Total_Oil Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.69	0.058	7.39E-03	0.054	0.0045	0.75	12.80
CO	1.98E-02	0.18	0.016	7.26E-02	0.53	0.044	0.71	12.18
VOC [c]	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.055	0.94
SO_2	4.57E-05	0.00043	0.000036	2.83E-05	0.00021	0.000017	0.00063	0.011
PM_{10}	4.22E-03	0.039	0.0033	1.94E-04	0.0014	0.00012	0.041	0.70
$PM_{2.5}$	4.09E-03	0.038	0.0032	1.79E-04	0.0013	0.00011	0.039	0.68
Greenhouse Gases								
CO_2	6.73E+00	62.74	5.27	1.61E+00	11.67	0.98	74.41	1275.16
CH_4	6.56E-05	0.00061	0.000051	2.08E-04	0.0015	0.00013	0.0021	0.036
N_2O	1.20E-05	0.00011	0.0000094	8.05E-05	0.00058	0.000049	0.00070	0.012
CO_2e [d]	---	62.79	5.27	---	11.89	1.00	74.67	1279.62

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

13. Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	204	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/well) * Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.169	0.62
CO	1.98E-02	0.041	0.00074	7.26E-02	0.15	0.0027	0.19	0.70
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0139	0.051
SO_2	4.57E-05	0.00009	0.0000017	2.83E-05	0.000059	0.0000011	0.00015	0.00056
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00040	0.0000072	0.0091	0.034
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00037	0.0000067	0.0088	0.032
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	3.34	0.060	17.28	63.44
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00043	0.0000078	0.00057	0.0021
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00017	0.0000030	0.00019	0.00070
CO_2e [d]	---	13.95	0.25	---	3.40	0.061	17.35	63.71

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

14. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation	144	hours/oil well
Development Rate	204	oil wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

Emissions (ton/year) = Emission Factor (lb/hp-hr) * horsepower (hp) * Hours (hour/year) * Load factor / 2000 lb/ton

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1, 10/96

Drill Rig Emissions (Tier 4)				
Species	Drill Rig E. Factor (lb/hp-hr)	Drill Rig Emissions (lb/hr)	Oil Well Drill Rig Emissions (tons/yr-well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC				
NOx [a]	5.73E-03	5.21	0.38	76.53
CO [a]	5.73E-03	5.21	0.38	76.53
VOC [a]	3.09E-04	0.28	0.02	4.12
PM_{10} [a]	6.61E-05	0.06	0.004	0.88
$PM_{2.5}$ [a]	6.61E-05	0.06	0.004	0.88
SO_2 [b]	1.21E-05	0.011	0.00079	0.16
Hazardous Air Pollutants				
Benzene [c]	5.43E-06	0.0049	0.00036	0.073
Toluene [c]	1.97E-06	0.0018	0.00013	0.026
Xylenes [c]	1.35E-06	0.0012	0.000088	0.018
Formaldehyde [c]	5.52E-07	0.00050	0.000036	0.0074
Acetaldehyde [c]	1.76E-07	0.00016	0.000012	0.0024
Acrolein [c]	5.52E-08	0.00005	0.0000036	0.00074
Naphthalene [d]	9.10E-07	0.00083	0.000060	0.012
POM 2 [d,e,f]	5.39E-07	0.00049	0.000035	0.0072
POM 5 [d,e,g]	4.22E-09	0.0000038	0.00000028	0.000056
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000011	0.00022
POM 7 [d,e,i]	1.07E-08	0.000010	0.00000070	0.00014
Greenhouse Gases				
CO_2 [j]	1.14	1037.47	74.70	15,238
CH_4 [j,k]	4.63E-05	0.042	0.0030	0.62
N_2O [j,k]	9.26E-06	0.0084	0.00061	0.12
CO_2e [m]	---	1040.96	74.95	15,290

a Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM) Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr

d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

i POM 7 includes: Chrysene.

j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

l Assumes maximum development scenario

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

15. Well Fracturing Engine

Average Gallons of Diesel used per Frac Job	566	gallons/well (oil well)
Hours per frac job	25.2	hours/well (oil well)
Development Rate - Oil Wells	204	wells/year (oil wells)
Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

Species	Frac Engine Emissions				
	E. Factor (lb/MMBtu)	**E. Factor (lb/hp-hr)**	**Engine Emissions (lb/hr)**	**Engine Emissions (tons/yr-well)**	**Emissions [k] (tons/yr)**
Criteria Pollutants & VOC					
NOx [a]	3.2	0.024	9.84	0.12	25.32
CO [a]	0.85	5.50E-03	2.62	0.033	6.72
VOC [a]	0.09	7.05E-04	0.28	0.0035	0.71
PM_{10} [a]	0.10	0.0007	0.31	0.0039	0.79
$PM_{2.5}$ [a]	0.10	0.0007	0.31	0.0039	0.79
SO_2 [a]	1.52E-03	1.21E-05	0.0047	0.000059	0.012
Hazardous Air Pollutants					
Benzene [b]	7.76E-04	5.43E-06	0.0024	0.000030	0.0061
Toluene [b]	2.81E-04	1.97E-06	0.00086	0.000011	0.0022
Xylenes [b]	1.93E-04	1.35E-06	0.00059	0.0000075	0.0015
Formaldehyde [b]	7.89E-05	5.52E-07	0.00024	0.0000031	0.00062
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000078	0.0000010	0.00020
Acrolein [b]	7.88E-06	5.52E-08	0.000024	0.00000031	0.000062
Naphthalene [c]	1.30E-04	9.10E-07	0.00040	0.0000050	0.0010
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00024	0.0000030	0.00061
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000019	0.000000023	0.0000048
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000073	0.000000092	0.000019
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000047	0.000000059	0.000012
Greenhouse Gases					
CO_2 [i]	163.05	1.14	501.6	6.32	1289.9
CH_4 [j]	6.61E-03	4.63E-05	0.020	0.00026	0.052
N_2O [j]	1.32E-03	9.26E-06	0.0041	0.000051	0.010
CO_2e [l]	---	---	503.3	6.3	1,294.3

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

KLEINFELDER

Project: GMBU - Alternative A - Oil Wells
Date: 7/15/2013

16. Oil Well Development Venting

Following completion, oil wells are vented prior to connnection to the gathering pipeline. Gas wells are connected to a sales line during completion.

Amount of Vented Gas:	5.0	Mscf per well (Average volume estimated)
Development Rate:	204	oil wells per year
Control Rate	0	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/well)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.04	83.858	13.453	0.674	4.193	8.86E-02	18.08
Ethane	30.07	7.944	2.389	0.120	0.397	1.57E-02	3.21
Propane	44.10	4.313	1.902	0.095	0.216	1.25E-02	2.56
i-Butane	58.12	0.687	0.399	0.020	0.034	2.63E-03	0.54
n-Butane	58.12	1.284	0.746	0.037	0.064	4.92E-03	1.00
i-Pentane	72.15	0.332	0.240	0.012	0.017	1.58E-03	0.32
n-Pentane	72.15	0.375	0.270	0.014	0.019	1.78E-03	0.36
Hexanes	86.18	0.134	0.116	0.00580	0.0067	7.63E-04	0.16
Heptanes	100.20	0.055	0.055	0.00274	0.0027	3.60E-04	0.074
Octanes	114.23	0.0085	0.010	0.00049	0.0004	6.40E-05	0.013
Nonanes	128.26	0.00080	0.001	0.00005	0.00004	6.76E-06	0.0014
Decanes +	142.29	0.00010	0.0001	0.00001	0.00001	9.37E-07	0.00019
Benzene	78.12	0.0052	0.004	0.00020	0.0003	2.68E-05	0.0055
Toluene	92.13	0.0023	0.002	0.00011	0.0001	1.40E-05	0.0028
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.00001	0.00001	1.40E-06	0.00029
n-Hexane	86.18	0.082	0.070	0.00353	0.0041	4.64E-04	0.095
Helium	4.00	----	---	---	---	---	---
Nitrogen	28.01	0.647	0.181	0.00908	0.0323	1.19E-03	0.24
Carbon Dioxide	44.01	0.268	0.118	0.00591	0.0134	7.76E-04	0.16
Oxygen	32.00	----	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.00009	0.0003	1.12E-05	0.0023
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.4**	**0.025**	**5.13**
HAP Subtotal		**0.09**	**0.08**	**0.004**	**0.004**	**0.0005**	**0.10**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**26.82**

a Assumes maximum development scenario

Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

17. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.191
Non-HC Wt. Fraction:	0.015
Total:	1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

18. Operations Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	575,626	miles/year-all wells
Operation Pickup Truck Mileage:	171,615	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	8.45	15.43	6.05E-03	0.28	0.52	8.74	15.95
CO	1.02E-02	1.61	2.94	4.48E-02	2.11	3.84	3.71	6.78
VOC [c]	1.55E-03	0.24	0.45	1.61E-03	0.08	0.14	0.32	0.58
SO_2	3.07E-05	0.005	0.009	1.84E-05	0.0009	0.0016	0.006	0.010
PM_{10}	2.57E-03	0.41	0.74	1.31E-04	0.006	0.011	0.41	0.75
$PM_{2.5}$	2.50E-03	0.39	0.72	1.21E-04	0.006	0.010	0.40	0.73
Greenhouse Gases								
CO_2	4.520	712.8	1,300.9	1.050	49.4	90.1	762.2	1,391.0
CH_4	2.59E-05	0.0041	0.007	9.38E-05	0.004	0.008	0.008	0.016
N_2O	4.01E-06	0.0006	0.0012	2.68E-05	0.0013	0.0023	0.0019	0.0035
CO_2e [c]	---	713.1	1,301.4	---	49.9	91.0	763.0	1392.4

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

19. Operations Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of wells not producing to GOSP	1450	wells

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	63
Light Trucks	8,000	19
Mean Vehicle Weight	36,457	---
Total Round Trips	---	82

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.56	1.37	0.16	0.26	382.52
$PM_{2.5}$	0.16	0.14	0.016	0.026	38.25

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.027	0.027	0.00094	0.0017	2.47
$PM_{2.5}$	0.0066	0.0066	0.00023	0.00042	0.61

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

20. Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	13,195	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	1088	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	362	well pads
Control Efficiency of tanks:	95	%
Average Throughput:	92,959	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.56	0.028	836.80
Hazardous Air Pollutants [b]			
Benzene	0.0018	0.000089	2.66
Toluene	0.0017	0.000083	2.46
Ethylbenzene	0.000092	0.0000046	0.14
Xylenes	0.00053	0.000026	0.78
n-Hexane	0.028	0.0014	41.88
Greenhouse Gases [b]			
CO_2	0.0044	0.0044	9.51
CH_4	0.13	0.0067	200.37
CO_2e	2.83	0.15	4217.32

a Total wellsite working and breathing emissions are based on 1452 uncontrolled tanks and 724 tanks controlled at 95%.
b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

21. Oil Storage Tank Flashing Emissions

Assumptions:

Oil Production Rate :	13,195	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	1088	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	362	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 102.39 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT PERCENT	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	16.58	39.82	307.20
Ethane	30.07	16.516	4.97	13.20	16.91	244.55
Propane	44.10	16.909	7.46	19.81	17.31	367.19
i-Butane	58.12	3.694	2.15	5.71	3.78	105.72
n-Butane	58.12	9.044	5.26	13.97	9.26	258.83
i-Pentane	72.15	3.269	2.36	6.27	3.35	116.14
n-Pentane	72.15	4.297	3.10	8.24	4.40	152.66
Cyclopentane	70.10	0.361	0.25	0.67	0.37	12.46
Hexanes	86.18	2.285	1.97	5.23	2.34	96.97
Heptanes	100.20	1.423	1.43	3.79	1.46	70.21
Octanes	114.23	0.403	0.46	1.22	0.41	22.67
Nonanes	128.26	0.076	0.10	0.26	0.078	4.80
Decanes +	142.29	0.026	0.037	0.098	0.027	1.82
Benzene	78.11	0.106	0.083	0.22	0.109	4.08
Toluene	92.14	0.083	0.076	0.20	0.085	3.77
Ethylbenzene	106.17	0.004	0.004	0.011	0.0041	0.21
Xylenes	106.17	0.023	0.024	0.065	0.0236	1.20
n-Hexane	86.18	1.513	1.30	3.46	1.55	64.21
Nitrogen	28.01	0.612	0.17	0.46	0.63	8.44
Carbon Dioxide	44.01	0.460	0.20	0.54	0.47	9.97
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**69.23**	**44.56**	**1282.94**
HAP SUBTOTAL		**1.73**	**1.49**	**3.96**	**1.77**	**73.46**
TOTAL		**100.0**	**37.63**	**100.0**	**102.39**	**1853.10**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	856.08	21.34	877.42
Hazardous Air Pollutants [b]			
Benzene	2.72	0.068	2.79
Toluene	2.51	0.063	2.58
Ethylbenzene	0.14	0.0035	0.14
Xylenes	0.80	0.020	0.82
n-Hexane	42.84	1.07	43.91
Greenhouse Gases [b]			
CO_2	6.65	6.65	13.30
CH_4	204.99	5.11	210.10
CO_2e	4311.40	113.97	4425.4

a Total wellsite flashing emissions are based on 1452 uncontrolled tanks and 724 tanks controlled at 95%.

22. Oil Truck Loadout

Assumptions:

Oil Well Production Rate	9.1	bbl/day-well
Number of Oil Wells not going to a GOSP	1450	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (°R)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [b]
Oil Loading [a]	0.6	2.8	50	520	2.01	9.1	0.14	203.70

	Oil Loading	
	tpy-well [c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.00045	0.65
Toluene	0.00041	0.60
Ethylbenzene	0.000023	0.033
Xylenes	0.00013	0.19
n-Hexane	0.0070	10.19
Greenhouse Gases		
CO2	0.00109	1.58
CH4	0.034	48.78
CO2e	0.71	1025.9

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60°F.
b Assumes maximum development scenario
c Emissions estimated based on flashing analysis weight fractions

23. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.00080	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.0023	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.320

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Proposed Action	3,250	397.90	1,402.92	12.29	29,474

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

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Project: GMBU - Alternative A - Oil Wells

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24. Wellsite Pumping Unit Engines

Assumptions:

Pumpjack Engine power:	65.0	hp
Number of Wells Requiring Pumping Unit Engines:	3250	wells
Load Factor:	0.38	

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)} * \text{load factor}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [a] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/well)	Emissions (ton/yr-well)	Total Emissions [h] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [b]	-	1.89	0.10	0.45	1,465.02
CO [b]	-	2.58	0.14	0.62	1,999.87
VOC [a]	0.12	5.12E-01	0.028	0.12	396.60
PM_{10} [a,d]	4.83E-02	2.06E-01	0.011	0.049	159.67
$PM_{2.5}$ [a,d]	4.83E-02	2.06E-01	0.011	0.049	159.67
SO_2 [a]	5.88E-04	2.51E-03	0.00014	0.0006	1.94
Hazardous Air Pollutants [a]					
Benzene	1.94E-03	8.27E-03	0.00045	0.0020	6.41
Toluene	9.63E-04	4.11E-03	0.00022	0.0010	3.18
Ethylbenzene	1.08E-04	4.60E-04	0.000025	0.00011	0.36
Xylenes	2.68E-04	1.14E-03	0.000062	0.00027	0.89
Formaldehyde	5.52E-02	2.35E-01	0.013	0.056	182.44
Acetaldehyde	7.76E-03	3.31E-02	0.0018	0.0079	25.65
Acrolein	7.78E-03	3.32E-02	0.0018	0.0079	25.71
Benzo(a)pyrene/POM5	5.68E-09	2.42E-08	1.32E-09	0.00000001	0.000019
Biphenyl	3.95E-06	1.68E-05	0.0000009	0.0000040	0.013
Methanol	2.48E-03	1.06E-02	0.00058	0.0025	8.20
1,1,2,2-Tetrachloroethane	6.63E-05	2.83E-04	0.000015	0.000067	0.22
1,1,2-Trichloroethane	5.27E-05	2.25E-04	0.000012	0.000054	0.17
1,3-Dichloropropene	4.38E-05	1.87E-04	0.000010	0.000045	0.14
1,3-Butadiene	8.20E-04	3.50E-03	0.00019	0.00083	2.71
2,2,4-Trimethylpentane	8.46E-04	3.61E-03	0.00020	0.00086	2.80
Carbon Tetrachloride	6.07E-05	2.59E-04	0.000014	0.000062	0.20
Chlorobenzene	4.44E-05	1.89E-04	0.000010	0.000045	0.15
Chloroform	4.71E-05	2.01E-04	0.000011	0.000048	0.16
Chrysene/POM7	6.72E-07	2.87E-06	0.00000016	0.0000007	0.0022
Ethylene Dibromide	7.34E-05	3.13E-04	0.000017	0.000075	0.24
Methylene Chloride	1.47E-04	6.27E-04	0.000034	0.00015	0.49
n-Hexane	4.45E-04	1.90E-03	0.00010	0.00045	1.47
Naphthalene	9.63E-05	4.11E-04	0.000022	0.000098	0.32
Phenol	4.21E-05	1.80E-04	0.000010	0.000043	0.14
Styrene	5.48E-05	2.34E-04	0.000013	0.000056	0.18
Vinyl Chloride	2.47E-05	1.05E-04	0.0000057	0.000025	0.082
PAH	1.34E-04	5.71E-04	0.000031	0.00014	0.44
POM -2 [e]	3.28E-05	1.40E-04	0.0000076	0.000033	0.11
POM-6 [f]	3.50E-07	1.49E-06	0.00000008	0.0000004	0.0012
Greenhouse Gases					
CO_2 [g]	117	498	27.14	118.9	386,316
CH_4 [g]	0.002	0.01	0.00051	0.0022	7.29
N_2O [g]	0.0002	0.0009	0.000051	0.00022	0.73
CO_2e [i]	----	----	27.17	118.98	386,694

a AP-42 Table 3.2-1 Uncontrolled Emission Factors for 2-Stroke Lean-Burn Engines, 7/00
b Emission factors (g/hp-hr) from manufacturer specifications
c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d PM = sum of PM filterable and PM condensable
e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, benzo(a)fluoranthene, benzo(e)pyrene, fluorene, phenanthrene, perylene, and pyrene.
f POM 6 includes: Benz(a)anthracene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.
h Estimated at full project production.
i Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

25. Production Heater Emissions

Assumptions

Oil Wellsite Separator Heater Size	500	Mbtu/hr
Oil Wellsite Tank Heater Size	250	Mbtu/hr per tank
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Oil wells with heater treaters	1450	wells
Oil well tanks	2,176	tanks
Load Factor	0.6	load rate

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Oil Well Separator Heater			Oil Well Tank Heaters			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Total Emissions (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.029	0.13	100	0.029	0.13	74.65	326.95
CO [a]	84	0.025	0.11	84	0.025	0.11	62.70	274.64
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	4.11	17.98
SO_2 [b]	0.6	0.00018	0.00077	0.6	0.00018	0.00077	0.45	1.96
PM_{10} [b]	7.6	0.0022	0.0098	7.6	0.0022	0.0098	5.67	24.85
$PM_{2.5}$ [b]	7.6	0.0022	0.0098	7.6	0.0022	0.0098	5.67	24.85
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.18E-07	2.71E-06	2.10E-03	6.18E-07	2.71E-06	0.0016	0.0069
Toluene [c]	3.40E-03	1.00E-06	4.38E-06	3.40E-03	1.00E-06	4.38E-06	0.0025	0.011
Hexane [c]	1.80E+00	5.29E-04	2.32E-03	1.80E+00	5.29E-04	2.32E-03	1.34	5.89
Formaldehyde [c]	7.50E-02	2.21E-05	9.66E-05	7.50E-02	2.21E-05	9.66E-05	0.056	0.25
Dichlorobenzene [c]	1.20E-03	3.53E-07	1.55E-06	1.20E-03	3.53E-07	1.55E-06	0.00090	0.0039
Naphthalene [c]	6.10E-04	1.79E-07	7.86E-07	6.10E-04	1.79E-07	7.86E-07	0.00046	0.0020
POM 2[c,d,e]	5.90E-05	1.74E-08	7.60E-08	5.90E-05	1.74E-08	7.60E-08	0.000044	0.00019
POM 3[c,f]	1.60E-05	4.71E-09	2.06E-08	1.60E-05	4.71E-09	2.06E-08	0.000012	0.000052
POM 4[c,g]	1.80E-06	5.29E-10	2.32E-09	1.80E-06	5.29E-10	2.32E-09	0.000001	0.000006
POM 5[c,h]	2.40E-06	7.06E-10	3.09E-09	2.40E-06	7.06E-10	3.09E-09	0.000002	0.000008
POM 6[c,i]	7.20E-06	2.12E-09	9.28E-09	7.20E-06	2.12E-09	9.28E-09	0.000005	0.000024
POM 7[c,j]	1.8E-06	5.29E-10	2.32E-09	1.8E-06	5.29E-10	2.32E-09	0.000001	0.000006
Greenhouse Gases								
CO_2 [l]	119,226	35.07	153.59	119,226	35.07	153.59	88,998	389,813
CH_4 [l]	2.25	0.00066	0.0029	2.25	0.00066	0.0029	1.68	7.35
N_2O [l]	0.22	0.000066	0.00029	0.22	0.000066	0.00029	0.17	0.74
CO_2e [m]	---	35.10	153.74	---	35.10	153.74	89,086	390,195

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

26. Oil Well Fugitives

Number of Producting Wells 3250 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.042
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.117
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.015
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	----
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	----
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.00023
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.016
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.050
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-well)						0.37
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**1198.00**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	3.31
Toluene Emissions	0.00011	0.0020	2.97
Ethylbenzene Emissions	----	0.00011	0.16
Xylene Emissions	0.000011	0.00065	0.92
n-Hexane Emissions	0.0035	0.035	52.55

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26. Oil Well Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	19	8,760	0.84	0.0027	0.121	0.36	0.0031	7.51
Connectors - Gas	29	8,760	0.84	0.0027	0.017	0.08	0.0007	1.61
Open-Ended Lines - Gas	1	8,760	0.84	0.0027	0.031	0.005	0.00004	0.10
Flanges - Light Oil	32	8,760	0.84	0.0027	0.003	0.015	0.00013	0.31
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						0.59	0.0052	12.47
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**1929.15**	**16.88**	**40,529**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

27. Wellsite Flare Emissions

Assumptions:

Number of oil well pads with controls	362	well pads
Vent gas from each well pad	7.66	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.02	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [c] (lb/hr)	Total Emissions [c] (tons/yr)
Criteria Pollutants					
NOx [a]	0.068	0.0011	0.005	0.40	1.73
CO [a]	0.37	0.006	0.026	2.15	9.44
Greenhouse Gases					
CO2 [b]	---	2.05	9.00	744	3,257
CH4 [b]	---	0.0063	0.028	2.28	10.00
N2O [b]	---	0.000002	0.000009	0.0008	0.0033
CO2e [b]	---	2.19	9.58	792	3,468

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

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Project: GMBU - Alternative A - Oil Wells

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28. Compressor Station Engines

Assumptions:

Number of new compressor stations	1	facilities
Number of expanded compressor stations	3	facilities
Compressor Engine Capacity	8000	hp

Equations:

Emission Factor (g/hp-hr) = average heat rate of 8,000 btu/hp-hr (8,000/1,000,000 *453.6 = 3.6288 multiplier)

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ g/lb} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions Per Facility (lb/hr-facility)	Emissions Per Facility (tons/yr-facility)	Emissions [i] Total (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	17.64	77.25	308.99
CO [a]	-	2.0	35.27	154.50	617.99
VOC [a]	-	0.7	12.35	54.07	216.30
PM_{10} [b,c]	9.95E-03	0.036	0.64	2.79	11.15
$PM_{2.5}$ [b,c]	9.95E-03	0.036	0.64	2.79	11.15
SO_2 [b]	5.88E-04	0.002	0.038	0.16	0.66
Hazardous Air Pollutants [b]					
Benzene	4.40E-04	1.60E-03	0.014	0.062	0.25
Toluene	4.08E-04	1.48E-03	0.013	0.057	0.23
Ethylbenzene	3.97E-05	1.44E-04	0.0013	0.0056	0.022
Xylenes	1.84E-04	6.68E-04	0.0059	0.026	0.10
n-Hexane	1.11E-03	4.03E-03	0.036	0.16	0.62
Formaldehyde	5.28E-02	1.92E-01	1.69	7.40	29.60
Acetaldehyde	8.36E-03	3.03E-02	0.27	1.17	4.69
Acrolein	5.14E-03	1.87E-02	0.16	0.72	2.88
Methanol	2.50E-03	9.07E-03	0.080	0.35	1.40
1,1,2,2-Tetrachloroethane	4.00E-05	1.45E-04	0.0013	0.0056	0.022
1,1,2-Trichloroethane	3.18E-05	1.15E-04	0.0010	0.0045	0.018
1,3-Dichloropropene	2.64E-05	9.58E-05	0.00084	0.0037	0.015
1,3-Butadiene	2.67E-04	9.69E-04	0.0085	0.037	0.15
2,2,4-Trimethylpentane	2.50E-04	9.07E-04	0.0080	0.035	0.14
Biphenyl	2.12E-04	7.69E-04	0.0068	0.030	0.12
Carbon Tetrachloride	3.67E-05	1.33E-04	0.0012	0.0051	0.021
Chlorobenzene	3.04E-05	1.10E-04	0.0010	0.0043	0.017
Chloroform	2.85E-05	1.03E-04	0.00091	0.0040	0.016
Ethylene Dibromide	4.43E-05	1.61E-04	0.0014	0.0062	0.025
Methylene Chloride	2.00E-05	7.26E-05	0.00064	0.0028	0.011
Naphthalene	7.44E-05	2.70E-04	0.0024	0.010	0.042
Phenol	2.40E-05	8.71E-05	0.00077	0.0034	0.013
Styrene	2.36E-05	8.56E-05	0.00076	0.0033	0.013
Tetrachloroethane	2.48E-06	9.00E-06	0.000079	0.00035	0.0014
Vinyl Chloride	1.49E-05	5.41E-05	0.00048	0.0021	0.0084
PAH -POM 1 [d,e]	2.69E-05	9.76E-05	0.00086	0.0038	0.015
POM 2 [d,f]	5.93E-05	2.15E-04	0.0019	0.0083	0.033
Benzo(b)fluoranthene/POM6	1.66E-07	6.02E-07	0.0000053	0.000023	0.000093
Chrysene/POM7	6.93E-07	2.51E-06	0.000022	0.00010	0.00039
Greenhouse Gases					
CO_2 [g]	117	424	7,481	32,766	131,064
CH_4 [g]	0.002	0.0080	0.14	0.62	2.47
N_2O [g]	0.0002	0.00080	0.014	0.062	0.25
CO_2e [h]	---	---	7,488	32,798	131,193

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00, with 50% control from catalyst for HAPs

c PM = sum of PM filterable and PM condensable

d Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP-42 Table 1.4-3 footnotes.

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

h Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

i Assumes maximum development scenario

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29. Compressor Station Condensate Tanks

Assumptions:

Average Condensate Production Rate :

Facility Production Rate	73.5	bbls per day per facility
Tank Control Efficiency	95	%
Total Facilities	4	Compressor Stations
Number of Tanks at Comp Station	4	tanks/facility

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0

Emission factors referenced from Gasco FEIS

Controlled by combustion device with 95% efficiency

Component	**Tank Emissions (tons/yr/Tank)**	**Controlled Tank Emissions (tons/yr/Tank)**	**Total[a] Emissions (tons/yr)**
Total VOC	6.52	0.33	5.21
Hazardous Air Pollutants			
Benzene	0.063	0.0032	0.051
Toluene	0.11	0.0053	0.085
Ethylbenzene	0.0046	0.00023	0.0037
Xylenes	0.038	0.0019	0.030
n-Hexane	0.17	0.0084	0.13
Greenhouse Gases			
CO_2	1.32	1.32	21.07
CH_4	6.24	0.31	4.99
CO_2e	132	7.87	125.92

a Assumes maximum development scenario

30. Compressor Station Dehydrator Emissions

Assumptions

Number of Compressor Stations: 4 Stations
Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69	46.77
Hazardous Air Pollutants			
Benzene	0.13	0.56	2.24
Toluene	0.090	0.39	1.58
Ethylbenzene	---	---	---
Xylenes	0.016	0.070	0.28
n-Hexane	0.078	0.34	1.36
Greenhouse Gases			
CH_4	3.28	14.35	57.40
CO_2e	68.81	301.38	1205.50

a Assumes maximum development scenario

31. Compressor Station Fugitives

Number of Compressor Stations 4 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	114	8,760	0.19	4.50E-03	9.95E-03	0.95
Valves - Light Oil	28	8,760	0.41	2.50E-03	5.53E-03	0.28
Valves - Heavy Oil	0	8,760	0.41	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	28	8,760	0.41	9.80E-05	2.17E-04	0.011
Connectors - Gas	520	8,760	0.19	2.00E-04	4.42E-04	0.19
Connectors - Light Oil	44	8,760	0.41	2.10E-04	4.64E-04	0.04
Connectors - Heavy Oil	0	8,760	0.41	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	45	8,760	0.41	1.10E-04	2.43E-04	0.019
Open-Ended Lines - Gas	2	8,760	0.19	2.00E-03	4.42E-03	0.0074
Open-Ended Lines - Light Oil	0	8,760	0.41	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.41	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.41	2.50E-04	5.53E-04	---
Flanges - Gas	72	8,760	0.19	3.90E-04	8.62E-04	0.052
Flanges - Light Oil	0	8,760	0.41	1.10E-04	2.43E-04	---
Flanges - Heavy Oil	0	8,760	0.41	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	0	8,760	0.41	2.90E-06	6.41E-06	---
Other - Gas	91	8,760	0.19	8.80E-03	1.94E-02	1.48
Other - Light Oil	0	8,760	0.41	7.50E-03	1.66E-02	---
Other - Heavy Oil	0	8,760	0.41	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	0	8,760	0.41	1.40E-02	3.09E-02	---
Compressor station VOC Emissions (tons/yr)						**3.03**
Total Compressor station VOC Emissions (tons/yr)[d]						**12.10**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components referenced from similar existing facilities

b VOC and HAP weight fractions from wellsite gas analysis and compressor tank emissions

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Liquid Weight Fraction of VOCs	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.025
Toluene Emissions	0.0001	0.016	0.028
Ethylbenzene Emissions	----	0.00070	0.0010
Xylene Emissions	0.00001	0.0058	0.0085
n-Hexane Emissions	0.0035	0.026	0.23

31. Compressor Station Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	170	8,760	0.84	0.0027	0.121	3.20	0.028	67.17
Connectors - Gas	609	8,760	0.84	0.0027	0.017	1.61	0.014	33.81
Open-Ended Lines - Gas	2	8,760	0.84	0.0027	0.031	0.010	0.000084	0.20
Flanges - Light Oil	72	8,760	0.84	0.0027	0.003	0.034	0.00029	0.71
Other - Light Oil	91	8,760	0.84	0.0027	0.3	4.24	0.037	89.14
Compressor station GHG Emissions (tons/yr)						**9.09**	**0.080**	**191.0**
Total Compressor station GHG Emissions (tons/yr)[d]						**36.37**	**0.318**	**764.1**

a Number of components referenced from similar existing facilities
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

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32. Compressor Station Truck Loadout

Assumptions:

Facility Production Rate 74 bbls per day per facility

Total Facilities 4

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility	tpy[b]
12.46	0.6	5.2	66	520	4.94	74	2.78	11.13

	tpy-facility[c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.027	0.11
Toluene	0.045	0.18
Ethylbenzene	0.0020	0.0078
Xylenes	0.016	0.064
n-Hexane	0.071	0.29
Greenhouse Gases		
CO2	0.56	2.25
CH4	2.66	10.65
CO2e	56.50	226.0

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60^o F.

b Emission for full buildout

c Emissions estimated based on condensate tank analysis

33. Compressor Station Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	10,260	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.15	0.27	6.05E-03	0.00	0.00	0.15	0.27
CO	1.02E-02	0.03	0.05	4.48E-02	0.00	0.00	0.03	0.05
VOC [c]	1.55E-03	0.00	0.01	1.61E-03	0.00	0.00	0.00	0.01
SO_2	3.07E-05	0.000	0.000	1.84E-05	0.0000	0.0000	0.000	0.000
PM_{10}	2.57E-03	0.01	0.01	1.31E-04	0.000	0.000	0.01	0.01
$PM_{2.5}$	2.50E-03	0.01	0.01	1.21E-04	0.000	0.000	0.01	0.01
Greenhouse Gases								
CO_2	4.520	12.7	23.2	1.050	0.0	0.0	12.7	23.2
CH_4	2.59E-05	0.0001	0.000	9.38E-05	0.000	0.000	0.000	0.000
N_2O	4.01E-06	0.0000	0.0000	2.68E-05	0.0000	0.0000	0.0000	0.0000
CO_2e [c]	---	12.7	23.2	---	0.0	0.0	12.7	23.2

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

34. Compressor Station Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of Compressor Stations	4	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day All Facilities
Haul Trucks	45,000	1
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	1

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	0.80	1.28	5.13
$PM_{2.5}$	0.17	0.15	0.080	0.13	0.51

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.0051	0.0094	0.037
$PM_{2.5}$	0.0081	0.0081	0.0013	0.0023	0.0092

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

35. Gas and Oil Separation Facility Generators

Assumptions:

Number of GOSPs	12	Facilities
Generator size	1,945	Horsepower
Number of Generators per GOSP	1	engines/Facility

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}*8760\text{ (hr/yr)}}{453.6\text{ (g/lb)}*2000\text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (tons/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	4.29	18.78	225.37
CO [a]	-	2.0	8.58	37.56	450.75
VOC [a]	-	0.7	3.00	13.15	157.76
PM_{10} [b,d]	1.94E-02	7.92E-02	0.34	1.49	17.86
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.34	1.49	17.86
SO_2 [b]	5.88E-04	2.40E-03	0.010	0.045	0.54
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.014	0.061	0.73
Toluene	5.58E-04	2.28E-03	0.0049	0.021	0.26
Ethylbenzene	2.48E-05	1.01E-04	0.00022	0.0010	0.011
Xylenes	1.95E-04	7.96E-04	0.0017	0.0075	0.090
Formaldehyde	2.05E-02	8.37E-02	0.18	0.79	9.43
Acetaldehyde	2.79E-03	1.14E-02	0.024	0.11	1.28
Acrolein	2.63E-03	1.07E-02	0.023	0.10	1.21
Methanol	3.06E-03	1.25E-02	0.027	0.12	1.41
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.00022	0.0010	0.012
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.00013	0.00059	0.0070
1,3-Dichloropropene	1.27E-05	5.18E-05	0.00011	0.00049	0.0058
1,3-Butadiene	6.63E-04	2.71E-03	0.0058	0.025	0.30
Carbon Tetrachloride	1.77E-05	7.23E-05	0.00015	0.00068	0.0081
Chlorobenzene	1.29E-05	5.27E-05	0.00011	0.00049	0.0059
Chloroform	1.37E-05	5.59E-05	0.00012	0.00053	0.0063
Ethylene Dibromide	2.13E-05	8.70E-05	0.00019	0.00082	0.010
Methylene Chloride	4.12E-05	1.68E-04	0.00036	0.0016	0.019
Naphthalene	9.71E-05	3.96E-04	0.00085	0.0037	0.045
Styrene	1.19E-05	4.86E-05	0.00010	0.00046	0.0055
Vinyl Chloride	7.18E-06	2.93E-05	0.00006	0.00028	0.0033
PAH -POM 1	1.41E-04	5.76E-04	0.0012	0.0054	0.065
Greenhouse Gases					
CO_2 [e]	117	477.2	2046	8,962	107,542
CH_4 [e]	0.002	0.0090	0.0386	0.17	2.03
N_2O [e]	0.0002	0.00090	0.00386	0.02	0.20
CO_2e [f]	---	---	2048	2048.08	107647

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

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36. GOSP Truck Loadout

Assumptions:		
Facility Production Rate	5,000	bbls oil per day per facility
Total Facilities	12	central tank batteries
Control Efficiency	95	%

AP - 42, Chapter 5.2

$$L_L = 12.46 \times S \times P \times M / T$$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility[d]	tpy[b,d]
12.46	0.6	2.8	50	520	2.01	5000	3.86	46.31

	tpy-facility[c,d]	tpy[b,c,d]
Hazardous Air Pollutants		
Benzene	0.012	0.15
Toluene	0.011	0.14
Ethylbenzene	0.00063	0.0075
Xylenes	0.0036	0.043
n-Hexane	0.19	2.32
Greenhouse Gases		
CO2	0.030	0.36
CH4	0.92	11.09
CO2e	19.44	233.24

Notes:

a Vapor molecular weight and True Vapor Pressure (TVP) of the loaded liquid from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5.

b Emission for full buildout

c Emissions estimated based on oil flashing analysis

d Emissions controlled by 95%

37. GOSP Fugitives

Number of GOSP Facilities 12 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	372	8,760	0.19	4.50E-03	9.95E-03	3.10
Valves - Light Oil	390	8,760	0.69	2.50E-03	5.53E-03	6.53
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	74	8,760	0.69	9.80E-05	2.17E-04	0.049
Connectors - Gas	89	8,760	0.19	2.00E-04	4.42E-04	0.033
Connectors - Light Oil	66	8,760	0.69	2.10E-04	4.64E-04	0.09
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	22	8,760	0.69	1.10E-04	2.43E-04	0.02
Open-Ended Lines - Gas	17	8,760	0.19	2.00E-03	4.42E-03	0.0629
Open-Ended Lines - Light Oil	2	8,760	0.69	1.40E-03	3.09E-03	0.0188
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	---
Flanges - Gas	602	8,760	0.19	3.90E-04	8.62E-04	0.434
Flanges - Light Oil	1142	8,760	0.69	1.10E-04	2.43E-04	0.842
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	213	8,760	0.69	2.90E-06	6.41E-06	0.00414
Other - Gas	8	8,760	0.19	8.80E-03	1.94E-02	0.130
Other - Light Oil	4	8,760	0.69	7.50E-03	1.66E-02	0.201
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-facility)						11.61
TOTAL CTB VOC EMISSIONS (tons/yr)[d]						**139.32**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{2000 \text{ (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.35
Toluene Emissions	0.00011	0.0020	0.30
Ethylbenzene Emissions	----	0.00011	0.015
Xylene Emissions	0.000011	0.00065	0.091
n-Hexane Emissions	0.0035	0.035	5.55

37. GOSP Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	836	8,760	0.84	0.0027	0.121	15.72	0.138	330.31
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.004	9.83
Open-Ended Lines - Gas	19	8,760	0.84	0.0027	0.031	0.092	0.00080	1.92
Flanges - Light Oil	1957	8,760	0.84	0.0027	0.003	0.913	0.00798	19.17
Other - Light Oil	13	8,760	0.84	0.0027	0.3	0.61	0.0053	12.73
EMISSIONS (tons/yr-facility)						17.80	0.156	373.97
TOTAL CTB GHG EMISSIONS (tons/yr)[d]						**213.61**	**1.87**	**4487.60**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

Project: GMBU - Alternative A - Oil Wells

Date: 7/15/2013

38. GOSP Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	571,656	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{2000 \text{ (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	8.39	15.32	6.05E-03	0.00	0.00	8.39	15.32
CO	1.02E-02	1.60	2.92	4.48E-02	0.00	0.00	1.60	2.92
VOC [c]	1.55E-03	0.24	0.44	1.61E-03	0.00	0.00	0.24	0.44
SO_2	3.07E-05	0.005	0.009	1.84E-05	0.0000	0.0000	0.005	0.009
PM_{10}	2.57E-03	0.40	0.73	1.31E-04	0.000	0.000	0.40	0.73
$PM_{2.5}$	2.50E-03	0.39	0.71	1.21E-04	0.000	0.000	0.39	0.71
Greenhouse Gases								
CO_2	4.520	707.9	1,291.9	1.050	0.0	0.0	707.9	1,291.9
CH_4	2.59E-05	0.0041	0.007	9.38E-05	0.000	0.000	0.004	0.007
N_2O	4.01E-06	0.0006	0.0011	2.68E-05	0.0000	0.0000	0.0006	0.0011
CO_2e [c]	---	708.2	1,292.5	---	0.0	0.0	708.2	1292.5

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

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39. GOSP Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily	$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$
Daily	$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$
Annual	$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365\text{-}p)/365)$
Annual	$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365\text{-}p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily	$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$
Daily	$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$
Annual	$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1\text{-}(p/(365*4))$
Annual	$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1\text{-}(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of GOSP Facilities	12	facilities

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	16.85	26.95	323.44
$PM_{2.5}$	0.17	0.15	1.685	2.695	32.34

Vehicle Type[a]	**Weight (lbs)**	**Round Trips per Day All Facilities**
Haul Trucks	45,000	63
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	63

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.11	0.20	2.36
$PM_{2.5}$	0.0081	0.0081	0.026	0.048	0.58

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

40. Water Treatment Facility Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :

Facility Production Rate	160	bbls oil per day per facility
Total Facilities	13	water treatment facilities
No. Tanks at each facility	6	Tanks per facility
Throughput	2,452,800	gallons per year per facility
Throughput	408,800	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Tank Work / Breathing (tons/yr/tank)	Tank Work / Breathing (tons/yr/facility)	Total[a] Emissions (tons/yr)
Total VOC	1.02	6.097	79.25
Hazardous Air Pollutants			
Benzene	0.0032	0.019	0.25
Toluene	0.0030	0.018	0.23
Ethylbenzene	0.00017	0.00099	0.013
Xylenes	0.0010	0.0057	0.074
n-Hexane	0.051	0.31	3.97
Greenhouse Gases			
CO_2	0.0079	0.047	0.62
CH_4	0.24	1.46	18.98
CO_2e	5.12	30.70	399.14

a Emissions for full buildout

b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

KLEINFELDER	Project: GMBU - Alternative A - Oil Wells Date: 7/15/2013

41. Water Treatment Facility Oil Storage Tank Flashing Emissions

Vent Rate = 1241.60 scf/day-facility

* Gas to oil ratio * production per facility

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (scf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	482.91	3.73
Ethane	30.07	16.516	4.97	0.132	205.06	2.97
Propane	44.10	16.909	7.46	0.198	209.94	4.45
i-Butane	58.12	3.694	2.15	0.057	45.86	1.28
n-Butane	58.12	9.044	5.26	0.140	112.29	3.14
i-Pentane	72.15	3.269	2.36	0.063	40.59	1.41
n-Pentane	72.15	4.297	3.10	0.082	53.35	1.85
Cyclopentane	70.10	0.361	0.25	0.0067	4.48	0.151
Hexanes	86.18	2.285	1.97	0.052	28.37	1.18
Heptanes	100.20	1.423	1.43	0.038	17.67	0.85
Octanes	114.23	0.403	0.46	0.012	5.00	0.275
Nonanes	128.26	0.076	0.10	0.0026	0.94	0.0582
Decanes +	142.29	0.026	0.037	0.0010	0.323	0.0221
Benzene	78.11	0.106	0.083	0.0022	1.32	0.0494
Toluene	92.14	0.083	0.076	0.0020	1.03	0.0457
Ethylbenzene	106.17	0.004	0.0042	0.00011	0.0497	0.00254
Xylenes	106.17	0.023	0.024	0.00065	0.286	0.0146
n-Hexane	86.18	1.513	1.30	0.035	18.79	0.779
Nitrogen	28.01	0.612	0.17	0.0046	7.60	0.102
Carbon Dioxide	44.01	0.460	0.20	0.0054	5.71	0.121
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**0.692**	**540.29**	**15.56**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**21.47**	**0.89**
TOTAL		**100.00**	**37.63**	**1.000**	**1241.58**	**22.47**

Number of Water Treatment Facilities	**13**

Total Flashing Emissions for All Tanks (tons/yr)

VOC	202.24
Hazardous Air Pollutants	
Benzene	0.64
Toluene	0.59
Ethylbenzene	0.033
Xylenes	0.19
n-Hexane	10.12
HAPs	11.58
Greenhouse Gases	
CO2	1.57
CH4	48.43
CO2e	1018.5

42. Water Treatment Facility Fugitives

Number Water Treatment Facilities 13 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	19	8,760	0.19	4.50E-03	9.95E-03	0.16
Valves - Light Oil	29	8,760	0.69	2.50E-03	5.53E-03	0.49
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	29	8,760	0.69	9.80E-05	2.17E-04	0.019
Connectors - Gas	66	8,760	0.19	2.00E-04	4.42E-04	0.024
Connectors - Light Oil	99	8,760	0.69	2.10E-04	4.64E-04	0.14
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	99	8,760	0.69	1.10E-04	2.43E-04	0.073
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	1	8,760	0.69	1.40E-03	3.09E-03	0.0094
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	1	8,760	0.69	2.50E-04	5.53E-04	0.0017
Flanges - Gas	3	8,760	0.19	3.90E-04	8.62E-04	0.0022
Flanges - Light Oil	5	8,760	0.69	1.10E-04	2.43E-04	0.0037
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	5	8,760	0.69	2.90E-06	6.41E-06	0.00010
VOC EMISSIONS (tons/yr-facility)						0.92
TOTAL Water Treatment VOC EMISSIONS (tons/yr)[d]						**11.97**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.033
Toluene Emissions	0.00011	0.0020	0.029
Ethylbenzene Emissions	----	0.00011	0.0016
Xylene Emissions	0.000011	0.00065	0.0091
n-Hexane Emissions	0.0035	0.0346	0.52

42. Water Treatment Facility Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	77	8,760	0.84	0.0027	0.121	1.45	0.013	30.42
Connectors - Gas	264	8,760	0.84	0.0027	0.017	0.70	0.0061	14.65
Open-Ended Lines - Gas	3	8,760	0.84	0.0027	0.031	0.014	0.00013	0.30
Flanges - Light Oil	13	8,760	0.84	0.0027	0.003	0.0061	0.000053	0.13
EMISSIONS (tons/yr-facility)						2.17	0.019	45.51
TOTAL Water Treatment GHG EMISSIONS (tons/yr)[d]						**28.16**	**0.25**	**591.6**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

43. Water Treatment Plant Generator

Assumptions:

Number of facilities	13	
Generator horsepower	1,945	hp/engine

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}*8760 \text{ (hr/yr)}}{453.6 \text{ (g/lb)}*2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (ton/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	4.29	18.78	244.15
CO [a]	-	2.0	8.58	37.56	488.31
VOC [a]	-	0.7	3.00	13.15	170.91
PM_{10} [b,d]	1.94E-02	7.92E-02	0.340	1.49	19.35
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.340	1.49	19.35
SO_2 [b]	5.88E-04	2.40E-03	0.0103	0.045	0.586
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.014	0.061	0.79
Toluene	5.58E-04	2.28E-03	0.0049	0.021	0.28
Ethylbenzene	2.48E-05	1.01E-04	0.00022	0.0010	0.012
Xylenes	1.95E-04	7.96E-04	0.0017	0.0075	0.097
Formaldehyde	2.05E-02	8.37E-02	0.18	0.79	10.22
Acetaldehyde	2.79E-03	1.14E-02	0.024	0.11	1.39
Acrolein	2.63E-03	1.07E-02	0.023	0.10	1.31
Methanol	3.06E-03	1.25E-02	0.027	0.12	1.52
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.00022	0.0010	0.013
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.00013	0.00059	0.0076
1,3-Dichloropropene	1.27E-05	5.18E-05	0.00011	0.00049	0.0063
1,3-Butadiene	6.63E-04	2.71E-03	0.0058	0.025	0.33
Carbon Tetrachloride	1.77E-05	7.23E-05	0.00015	0.00068	0.0088
Chlorobenzene	1.29E-05	5.27E-05	0.00011	0.00049	0.0064
Chloroform	1.37E-05	5.59E-05	0.00012	0.00053	0.0068
Ethylene Dibromide	2.13E-05	8.70E-05	0.00019	0.00082	0.011
Methylene Chloride	4.12E-05	1.68E-04	0.00036	0.0016	0.021
Naphthalene	9.71E-05	3.96E-04	0.00085	0.0037	0.048
Styrene	1.19E-05	4.86E-05	0.00010	0.00046	0.0059
Vinyl Chloride	7.18E-06	2.93E-05	0.000063	0.00028	0.0036
PAH -POM 1	1.41E-04	5.76E-04	0.0012	0.0054	0.070
Greenhouse Gases					
CO_2 [e]	117	477.2	2,046	8,962	116,504
CH_4 [e]	0.002	9.00E-03	0.0386	0.17	2.20
N_2O [e]	0.0002	9.00E-04	0.00386	0.017	0.22
CO_2e [f]	---	---	2,048	8,971	116,618

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

44. Central Facility Heater Emissions

Assumptions

GOSP Heater Size	11	MMbtu/hr
Number of Heaters at each GOSP	3	heaters
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Development size	12	GOSP Facilities
	4	Compressor Stations

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	GOSP Heater Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	3.24	14.17	100	0.147	0.64	39.41	172.62
CO [a]	84	2.72	11.90	84	0.124	0.54	33.11	145.00
VOC [b]	5.5	0.18	0.78	5.5	0.008	0.04	2.17	9.49
SO_2 [b]	0.6	0.019	0.085	0.6	0.001	0.00	0.24	1.04
PM_{10} [b]	7.6	0.25	1.08	7.6	0.011	0.05	3.00	13.12
$PM_{2.5}$ [b]	7.6	0.25	1.08	7.6	0.011	0.05	3.00	13.12
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.79E-05	2.98E-04	2.10E-03	3.09E-06	1.35E-05	8.28E-04	0.0036
Toluene [c]	3.40E-03	1.10E-04	4.82E-04	3.40E-03	5.00E-06	2.19E-05	1.34E-03	0.0059
Hexane [c]	1.80E+00	5.82E-02	2.55E-01	1.80E+00	2.65E-03	1.16E-02	7.09E-01	3.11
Formaldehyde [c]	7.50E-02	2.43E-03	1.06E-02	7.50E-02	1.10E-04	4.83E-04	2.96E-02	0.13
Dichlorobenzene [c]	1.2E-03	3.88E-05	1.70E-04	1.2E-03	1.76E-06	7.73E-06	4.73E-04	0.0021
Naphthalene [c]	6.1E-04	1.97E-05	8.64E-05	6.1E-04	8.97E-07	3.93E-06	2.40E-04	0.0011
POM 2 [c,d,e]	5.9E-05	1.91E-06	8.36E-06	5.9E-05	8.68E-08	3.80E-07	2.33E-05	0.00010
POM 3 [c,f]	1.6E-05	5.18E-07	2.27E-06	1.6E-05	2.35E-08	1.03E-07	6.31E-06	0.000028
POM 4 [c,g]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	7.09E-07	0.0000031
POM 5 [c,h]	2.4E-06	7.76E-08	3.40E-07	2.4E-06	3.53E-09	1.55E-08	9.46E-07	0.0000041
POM 6 [c,i]	7.2E-06	2.33E-07	1.02E-06	7.2E-06	1.06E-08	4.64E-08	2.84E-06	0.000012
POM 7 [c,j]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	7.09E-07	0.0000031
Greenhouse Gases								
CO_2 [l]	119,226	3857.30	16894.98	119,226	175.3	767.95	46988.9	205812
CH_4 [l]	2.25	0.073	0.32	2.25	0.0033	0.014	0.89	3.88
N_2O [l]	0.22	0.0073	0.03	0.22	0.00033	0.0014	0.089	0.39
CO_2e [m]	---	3861.1	16911.5	---	175.50	768.71	47035	206013

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98
b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)
c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98
d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html
e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.
f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.
g POM 4 includes: 3-Methylchloranthrene.
h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.
i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.
j POM 7 includes: Chrysene.
k Assumes maximum development scenario
l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.
m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

45. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations 4
Number of GOSPs 12

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-facility)	Total Emissions (tons/yr-facility)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	14.30
CO [a]	0.37	1.11	4.86	77.79
Greenhouse Gases				
CO2 [b]	---	508	2,227	35,625
CH4 [b]	---	3.25	14.22	227.52
N2O [b]	---	0.0007	0.003	0.05
CO2e [b]	---	577	2,526	40,418

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification		
User Identification:	GMBU Water treatment tanks	
City:	Duchesne	
State:	Utah	
Company:	Newfield Exploration	
Type of Tank:	Vertical Fixed Roof Tank	
Description:	One (1) 500 bbl Storage Tank	
Tank Dimensions		
Shell Height (ft):		25.00
Diameter (ft):		12.00
Liquid Height (ft) :		24.00
Avg. Liquid Height (ft):		12.00
Volume (gallons):		20,304.71
Turnovers:		20.13
Net Throughput(gal/yr):		408,800.00
Is Tank Heated (y/n):	N	
Paint Characteristics		
Shell Color/Shade:	Gray/Light	
Shell Condition	Good	
Roof Color/Shade:	Gray/Light	
Roof Condition:	Good	
Roof Characteristics		
Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00
Breather Vent Settings		
Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

		Daily Liquid Surf. Temperature (deg F)			Liquid Bulk Temp	Vapor Pressure (psia)			Vapor Mol.	Liquid Mass	Vapor Mass	Mol.	Basis for Vapor Pressure
Mixture/Component	Month	Avg.	Min.	Max.	(deg F)	Avg.	Min.	Max.	Weight.	Fract.	Fract.	Weight	Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	962.6416
Vapor Space Volume (cu ft):	1,527.3376
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3229
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,527.3376
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	13.5046
Tank Shell Height (ft):	25.0000
Average Liquid Height (ft):	12.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3229
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	13.5046

Working Losses (lb):	1,069.5271
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	408,800.0000
Annual Turnovers:	20.1333
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	20,304.7110
Maximum Liquid Height (ft):	24.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	2,032.1687

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	1,069.53	962.64	2,032.17

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

50 MMscfd

Calculated Absorber Stages:	2.51	
Specified Dry Gas Dew Point:	5.00	lbs. H2O/MMSCF
Temperature:	125.0	deg. F
Pressure:	800.0	psig
Dry Gas Flow Rate:	50.0000	MMSCF/day
Glycol Losses with Dry Gas:	1.8232	lb/hr
Wet Gas Water Content:	Saturated	
Calculated Wet Gas Water Content:	137.42	lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00	gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

50 MMscfd		
2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

50 MMscfd

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

50 MMscfd

Flow Rate: 1.46e+001 gpm

NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F

Pressure: 14.70 psia

Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

50 MMscfd

Component	Conc.	Loading
Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification		
User Identification:	GMBU PA Tanks	
City:	Duchesne	
State:	Utah	
Company:	Newfield Exploration	
Type of Tank:	Vertical Fixed Roof Tank	
Description:	One (1) 400 bbl Storage Tank	
Tank Dimensions		
Shell Height (ft):		20.00
Diameter (ft):		12.00
Liquid Height (ft) :		19.00
Avg. Liquid Height (ft):		10.00
Volume (gallons):		16,074.56
Turnovers:		5.78
Net Throughput(gal/yr):		92,959.00
Is Tank Heated (y/n):	N	
Paint Characteristics		
Shell Color/Shade:	Gray/Light	
Shell Condition	Good	
Roof Color/Shade:	Gray/Light	
Roof Condition:	Good	
Roof Characteristics		
Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00
Breather Vent Settings		
Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMBU PA Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMBU PA Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	243.2049
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	92,959.0000
Annual Turnovers:	5.7830
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,124.5785

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMBU PA Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	243.20	881.37	1,124.58

APPENDIX A-2
PROPOSED ACTION GAS WELL EMISSIONS

Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative A - Gas Wells [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	23.0	8.5	2.0	0.0006	19.2	4.8
	Drilling	577.7	562.5	31.3	1.2	725.4	80.7
	Completion	67.4	22.8	2.6	0.039	384.7	41.1
	Interim Reclamation	0.5	0.5	0.04	0.0004	10.5	1.1
	Wind Erosion	---	---	---	---	5.3	0.8
Wellsite Production Emissions	Production Heaters	483.1	405.8	26.6	2.9	36.7	36.7
	Wellsite Tanks	---	---	1,773.5	---	---	---
	Pneumatics	---	---	306.1	---	---	---
	Fugitives	---	---	1,452.7	---	---	---
	Wellsite Truck Loading	---	---	189.2	---	---	---
	Wellsite Dehydrators	---	---	47.3	---	---	---
	Wellsite Flares	20.1	109.3	---	---	---	---
	Operations Vehicle	7.9	8.0	0.4	0.007	246.2	25.1
Gas Processing Plant Emissions	Gas Plant Compressor Engines	11.6	23.2	8.1	0.03	0.9	0.9
	Gas Plant Flares	0.9	4.9	---	---	---	---
	Gas Plant Fugitives	---	---	0.8	---	---	---
	Gas Plant Dehydrator Heater	0.6	0.5	0.04	0.004	0.05	0.05
	Gas Plant Dehydrator	---	---	11.7	---	---	---
Compressor Station Emissions	Compressor Station Engines	1,545.0	3,089.9	1,081.5	3.3	55.8	55.8
	Compressor Station Tanks	---	---	26.1	---	---	---
	Compressor Station Dehydrator	---	---	233.8	---	---	---
	Compressor Station Truck Loading and Vehicle Traffic	1.4	0.3	55.7	0.0	31.1	3.2
	Compressor Station Dehydrator Heater	12.9	10.8	0.7	0.1	1.0	1.0
	Compressor Station Flare	17.9	97.2	---	---	---	---
	Compressor Station Fugitives	---	---	60.5	---	---	---
	Total Emissions	**2,769.9**	**4,344.2**	**5,310.6**	**7.5**	**1,516.9**	**251.2**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b]					Total
	Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
Criteria Pollutants & VOC						
NO_X	23.0	577.7	67.4	0.5	---	668.6
CO	8.5	562.5	22.8	0.5	---	594.3
VOC	2.0	31.3	2.6	0.04	---	35.9
SO_2	0.0006	1.2	0.04	0.0004	---	1.2
PM_{10}	19.2	725.4	384.7	10.5	5.3	1145.1
$PM_{2.5}$	4.8	80.7	41.1	1.1	0.8	128.4
Hazardous Air Pollutants						
Benzene	---	0.51	0.010	---	---	0.52
Toluene	---	0.18	0.004	---	---	0.19
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.13	0.0026	---	---	0.13
n-Hexane	---	---	---	---	---	---
Formaldehyde	---	0.052	0.0011	---	---	0.053
Acetaldehyde	---	0.017	0.00034	---	---	0.017
Acrolein	---	0.0052	0.00011	---	---	0.0053
Naphthalene	---	0.085	0.0017	---	---	0.087
POM 2	---	0.050	0.0010	---	---	0.051
POM 5	---	0.00040	0.000008	---	---	0.00040
POM 6	---	0.0015	0.000032	---	---	0.0016
POM 7	---	0.0010	0.000021	---	---	0.0010
Greenhouses Gases						
CO_2	569.9	110,750	5,555	49	---	116,923
CH_4	0.0028	4.41	0.18	0.00159	---	4.60
N_2O	0.0010	0.89	0.04	0.00054	---	0.93
CO_2e	570.3	111,118	5,571	49	---	117,308

a Assumes maximum development scenario of 156 wells in one year

b Emissions in summary tables may vary slightly due to rounding differences.

c Total drilling emissions includes Tier IV drill rig engines

KLEINFELDER Bright People. Right Solutions.	Project: GMBU - Alternative A -Gas Wells Date: 7/15/2013

Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]								
	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Wellsite Flares	Wellsite Dehydrators	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	483.1	---	---	---	---	20.1	---	7.9	511.1
CO	405.8	---	---	---	---	109.3	---	8.0	523.1
VOC	26.6	1773.5	1452.7	189.2	306.1	---	47.3	0.4	3,795.8
SO_2	2.9	---	---	---	---	---	---	0.007	2.9
PM_{10}	36.7	---	---	---	---	---	---	246.2	283.0
$PM_{2.5}$	36.7	---	---	---	---	---	---	25.1	61.8
Hazardous Air Pollutants									
Benzene	0.010	17.25	3.97	1.84	0.33	---	2.75	---	26.15
Toluene	0.016	28.75	5.20	3.07	0.17	---	11.64	---	48.84
Ethylbenzene	---	1.25	0.20	0.13	---	---	3.41	---	4.99
Xylene	---	10.25	1.69	1.09	0.017	---	24.25	---	37.30
n-Hexane	8.70	45.50	28.85	4.85	5.65	---	---	---	93.56
Formaldehyde	0.36	---	---	---	---	---	---	---	0.36
Dichlorobenzene	0.0058	---	---	---	---	---	---	---	0.0058
Naphthalene	0.0029	---	---	---	---	---	---	---	0.0029
POM 2	0.00029	---	---	---	---	---	---	---	0.00029
POM 3	0.000077	---	---	---	---	---	---	---	0.000077
POM 4	0.0000087	---	---	---	---	---	---	---	0.0000087
POM 5	0.000012	---	---	---	---	---	---	---	0.000012
POM 6	0.000035	---	---	---	---	---	---	---	0.000035
POM 7	0.0000087	---	---	---	---	---	---	---	0.000009
Greenhouse Gases									
CO_2	575,965	358.3	33.9	38.2	9.5	24,974.9	---	746.9	602,127
CH_4	10.86	1698.3	3871.0	181.19	1,079.17	238.0	73.98	0.0173	7,152
N_2O	1.09	---	---	---	---	0.0	---	0.0045	1.13
CO_2e	576,530	36,022	81,324	3,843	22,672	29,986	1,553	749	752,679

a Assumes maximum development scenario of 2500 gas wells
b Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

Total Project Infrastructure Related Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]								
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Central Facility Flares	Dehydrators	Compressor Engines	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	13.5	---	---	---	18.8	---	1556.6	1.4	1,590.2
CO	11.4	---	---	---	102.1	---	3113.1	0.3	3,226.8
VOC	0.7	26.1	61.4	55.6	---	245.5	1089.6	0.04	1,479.0
SO_2	0.08	---	---	---	---	---	3.3	0.0008	3.4
PM_{10}	1.0	---	---	---	---	---	56.7	31.1	88.8
$PM_{2.5}$	1.0	---	---	---	---	---	56.7	3.2	60.9
Hazardous Air Pollutants									
Benzene	0.00028	0.254	0.125	0.54	---	11.76	1.27	---	13.95
Toluene	0.00046	0.423	0.142	0.90	---	8.27	1.16	---	10.89
Ethylbenzene	---	0.0184	0.0049	0.0392	---	---	0.11	---	0.17
Xylene	---	0.151	0.043	0.322	---	1.48	0.52	---	2.51
n-Hexane	0.24	0.67	1.18	1.43	---	7.13	3.11	---	13.77
Formaldehyde	0.010	---	---	---	---	---	148.49	---	148.50
Acetaldehyde	---	---	---	---	---	---	23.50	---	23.50
Acrolein	---	---	---	---	---	---	14.47	---	14.47
Methanol	---	---	---	---	---	---	7.08	---	7.08
1,1,2,2-Tetrachloroethane	---	---	---	---	---	---	0.11	---	0.11
1,1,2-Trichloroethane	---	---	---	---	---	---	0.090	---	0.090
1,3-Dichloropropene	---	---	---	---	---	---	0.074	---	0.074
1,3-Butadiene	---	---	---	---	---	---	0.76	---	0.76
2,2,4-Trimethylpentane	---	---	---	---	---	---	0.70	---	0.70
Biphenyl	---	---	---	---	---	---	0.59	---	0.59
Carbon Tetrachloride	---	---	---	---	---	---	0.10	---	0.10
Chlorobenzene	---	---	---	---	---	---	0.086	---	0.086
Chloroform	---	---	---	---	---	---	0.080	---	0.080
Dichlorobenzene	0.00016	---	---	---	---	---	---	---	0.00016
Ethylene Dibromide	---	---	---	---	---	---	0.12	---	0.12
Methylene Chloride	---	---	---	---	---	---	0.057	---	0.057
Naphthalene	0.000083	---	---	---	---	---	0.21	---	0.21
Phenol	---	---	---	---	---	---	0.067	---	0.067
Styrene	---	---	---	---	---	---	0.066	---	0.066
Tetrachloroethane	---	---	---	---	---	---	0.0070	---	0.0070
Vinyl Chloride	---	---	---	---	---	---	0.042	---	0.042
PAH -POM 1	---	---	---	---	---	---	0.079	---	0.079
POM 2	0.0000080	---	---	---	---	---	0.17	---	0.17
POM 3	0.0000022	---	---	---	---	---	---	---	0.0000022
POM 4	0.00000024	---	---	---	---	---	---	---	0.00000024
POM 5	0.00000032	---	---	---	---	---	---	---	0.00000032
POM 6	0.00000097	---	---	---	---	---	0.00047	---	0.00047
POM 7	0.00000024	---	---	---	---	---	0.0019	---	0.0019
Greenhouse Gases									
CO_2	16,127	105.3	1.61	11.24	36,935	---	660,849	116	714,145
CH_4	0.304	25.0	183.9	53.27	352.0	301.38	12.46	0.00066	928.3
N_2O	0.030	---	---	---	0.062	---	1.25	0.00010	1.3
CO_2e	16,143	630	3,864	1,130	44,345	6,329	661,498	116	734,054

a Assumes maximum development scenario of 2500 gas wells

b Emissions in summary tables may vary slightly due to rounding differences.

KLEINFELDER Bright People. Right Solutions.	Project: GMBU - Alternative A -Gas Wells Date: 7/15/2013

Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	668.6	511.1	1,590.2	2,769.9
CO	594.3	523.1	3,226.8	4,344.2
VOC	35.9	3,795.8	1,479.0	5,310.6
SO_2	1.2	2.9	3.4	7.5
PM_{10}	1,145.1	283.0	88.8	1,516.9
$PM_{2.5}$	128.4	61.8	60.9	251.2
Hazardous Air Pollutants				
Benzene	0.52	26.15	13.95	40.62
Toluene	0.19	48.84	10.89	59.92
Ethylbenzene	---	4.99	0.17	5.17
Xylene	0.13	37.30	2.51	39.94
n-Hexane	---	93.56	13.77	107.32
Formaldehyde	0.053	0.36	148.50	148.92
Acetaldehyde	0.017	---	23.50	23.52
Acrolein	0.0053	---	14.47	14.48
Methanol	---	---	7.08	7.08
1,1,2,2-Tetrachloroethane	---	---	0.11	0.11
1,1,2-Trichloroethane	---	---	0.090	0.090
1,3-Dichloropropene	---	---	0.074	0.074
1,3-Butadiene	---	---	0.76	0.76
2,2,4-Trimethylpentane	---	---	0.70	0.70
Biphenyl	---	---	0.59	0.59
Carbon Tetrachloride	---	---	0.10	0.10
Chlorobenzene	---	---	0.086	0.086
Chloroform	---	---	0.080	0.080
Dichlorobenzene	---	0.0058	0.00016	0.0060
Ethylene Dibromide	---	---	0.12	0.12
Methylene Chloride	---	---	0.057	0.057
Naphthalene	0.087	0.0029	0.21	0.30
Phenol	---	---	0.067	0.067
Styrene	---	---	0.066	0.066
Tetrachloroethane	---	---	0.0070	0.0070
Vinyl Chloride	---	---	0.042	0.042
(PAH) POM 1	---	---	0.079	0.079
POM 2	0.051	0.00029	0.17	0.22
POM 3	---	0.000077	0.0000022	0.000079
POM 4	---	0.0000087	0.0000002	0.000009
POM 5	0.00040	0.000012	0.0000003	0.00042
POM 6	0.0016	0.000035	0.00047	0.0021
POM 7	0.0010	0.000009	0.0019	0.0030
Total HAPs	1.05	211.21	238.28	450.54
Greenhouse Gases				
CO_2	116,923	602,127	714,145	1,433,195
CH_4	4.60	7,152	928	8,085
N_2O	0.931	1.13	1.34	3.40
CO_2e	117,308	752,679	734,054	1,604,040

a Emissions for Peak Field Development
b Emissions in summary tables may vary slightly due to rounding differences.

KLEINFELDER Bright People. Right Solutions.	Project: GMBU - Alternative A -Gas Wells Date: 7/15/2013

1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	3	days per well pad
	12	hours per day
	36	hours per well pad
Annual amount of well pads	156	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency
Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment
Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.035	5.53	1.97	0.035	5.53	11.07
PM_{15}	0.50	0.009	1.41	0.50	0.009	1.41	2.82
PM_{10}	0.38	0.007	1.06	0.38	0.007	1.06	2.11
$PM_{2.5}$	0.21	0.00372	0.58	0.21	0.004	0.58	1.16

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.
b Assumes maximum development scenario

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Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	3	day grading per well pad
	12	hours/day
	36	hours per well pad
Deep gas well pads	156	well pads/year
Oil well pads	0	well pads/year
Distance graded - Deep gas well	1.96	miles
Distance graded - Oil well	0.00	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = 0.040 * $(\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = 0.051 * $(\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Deep gas wells			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	5.27	0.15	0.0026	0.41
PM_{15}	2.52	0.07	0.0013	0.20
PM_{10}	1.51	0.042	0.00076	0.12
$PM_{2.5}$	0.16	0.005	0.000082	0.013

a Assumes maximum development scenario

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Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

3. Road Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	4	days per mile
	12	hours per day
	0.19	miles of road per well pad
	9	hours per well pad road
Annual amount of well pads with roads	156	pads with roads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content }\%)^{1.2} * (\text{soil moisture content }\%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.009	1.38	1.97	0.009	1.38	2.75
PM_{15}	0.50	0.002	0.35	0.50	0.002	0.35	0.70
PM_{10}	0.38	0.002	0.26	0.38	0.002	0.26	0.53
$PM_{2.5}$	0.21	0.0009	0.14	0.21	0.001	0.14	0.29

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.
b Assumes maximum development scenario

4. Road Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	9	hours per well pad roads
Road construction grading distance	0.37	miles road per well pad
Annual well pads	156	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Roads			Total Emissions
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	1.00	0.11	0.0005	0.08
PM_{15}	0.48	0.05	0.00024	0.037
PM_{10}	0.29	0.032	0.00014	0.022
$PM_{2.5}$	0.03	0.003	0.000016	0.0024

a Assumes maximum development scenario

5. Pipeline Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	10	days per mile
	12	hours per day
	0.19	miles of pipeline per well pad
	22	hours per well pad pipeline
Annual amount of well pads withpipeline	156	pads with pipeline/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs/hr) = 5.7 * (soil silt content %)$^{1.2}$ * (soil moisture content %)$^{-1.3}$* Control Efficiency
Emissions (PM_{15} lbs/hr) = 1.0 * (soil silt content %)$^{1.5}$ * (soil moisture content %)$^{-1.4}$ * Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment
Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.022	3.44	1.97	0.022	3.44	6.88
PM_{15}	0.50	0.006	0.88	0.50	0.006	0.88	1.75
PM_{10}	0.38	0.0042	0.66	0.38	0.0042	0.66	1.31
$PM_{2.5}$	0.21	0.0023	0.36	0.21	0.0023	0.36	0.72

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.
b Assumes maximum development scenario

6. Pipeline Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	22	hours per well pad pipeline
Pipeline construction grading distance	0.75	miles pipeline per well pad
Annual well pads	156	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Pipeline			Total Emissions
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	2.00	0.09	0.0010	0.16
PM_{15}	0.96	0.043	0.00048	0.07
PM_{10}	0.58	0.026	0.00029	0.04
$PM_{2.5}$	0.06	0.0028	0.000031	0.005

a Assumes maximum development scenario

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S) 5.1 AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles 19
Precipitation Days (P) 45 days per year (NCDC data for Ouray, UT 1955-2004)
W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles 6
Precipitation Days (P) 45 days per year
W = average weight in tons of vehicles traveling the road

Construction Emissions

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of pads per year	156	well pads/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.20	1.05	5.61	0.09	13.81
$PM_{2.5}$	0.12	0.11	0.56	0.009	1.38

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.015	0.014	0.023	0.00040	0.06
$PM_{2.5}$	0.0036	0.0035	0.006	0.00010	0.015

Drilling - Deep Gas Wells

Hours per day	24	hour/day
Days per deep gas well	55	day/well
Number of wells per year	156	wells /year

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	30,857	---
Total Round Trips	---	7

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.45	1.27	7.90	4.57	712.87
$PM_{2.5}$	0.15	0.13	0.79	0.46	71.29

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.023	0.022	0.041	0.0261	4.06
$PM_{2.5}$	0.0055	0.0054	0.010	0.0064	1.00

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7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S) 5.1 AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles 19
Precipitation Days (P) 45 days per year (NCDC data for Ouray, UT 1955-2004)
W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles 6
Precipitation Days (P) 45 days per year
W = average weight in tons of vehicles traveling the road

Interim Reclamation

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of wells per year	156	wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	1.35	1.19	4.21	0.07	10.37
$PM_{2.5}$	0.14	0.12	0.42	0.007	1.04

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	0.019	0.019	0.020	0.00035	0.05
$PM_{2.5}$	0.0047	0.0046	0.005	0.00009	0.013

Completion - Deep Gas Well

Hours per day	24	hour/day
Days per deep gas well	24	day/well
Number of wells per year	156	wells /year

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	4
Haul Trucks	45,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	35,750	---
Total Round Trips	---	8

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	1.55	1.36	9.64	2.43	379.85
$PM_{2.5}$	0.16	0.14	0.96	0.24	37.98

	Emission Factor		**Paved Road Emissions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	0.026	0.025	0.05	0.02	2.36
$PM_{2.5}$	0.006	0.006	0.01	0.004	0.58

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	**Paved Total tons/year**	**Total tons/year**
PM_{10}	1116.90	6.54	1123.44
$PM_{2.5}$	111.69	1.60	113.29

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

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8. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	377	acres total disturbance for roads and pipelines per year
	1,523,892	square meters total initial disturbance for roads and pipelines
	468	acres total disturbance for well pads per year
	1,893,926	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed (U_{10}^{+})	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\ U_{10}^{+}$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, $P = 0$ for $U^*< U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2-period	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2-period
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	10.68	0.00
PM_{10}	5.34	0.00
$PM_{2.5}$	0.80	0.00

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9. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction	3	days per well pad
Well pads per year	156	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.18	0.52
CO	1.98E-02	0.041	0.00074	7.26E-02	0.30	0.0054	0.34	0.96
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.021	0.060
SO_2	4.57E-05	0.000095	0.0000017	2.83E-05	0.00012	0.0000021	0.00021	0.00060
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00080	0.000014	0.010	0.027
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00074	0.000013	0.0092	0.026
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	6.67	0.12	20.61	57.88
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00086	0.000016	0.0010	0.0028
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00033	0.0000060	0.00036	0.0010
CO_2e [d]	---	13.95	0.25	---	6.79	0.12	20.75	58.25

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	156	new pads per year
Backhoe miles per pad	0.77	miles (Value assumed to be 1/4 of dozer or grader mileage)
Backhoe Hours	67.3	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer miles per pad	3.1	miles
Dozer Hours	67.3	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader miles per pad	3.1	miles
Motor Grader Hours	67.3	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horse Power} * \text{Hours} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)
Criteria Pollutants & VOC									
NOx	6.9	0.28	0.0094	8.38	1.48	0.050	8.38	2.52	0.085
CO	3.49	0.14	0.0047	2.7	0.48	0.016	2.70	0.81	0.027
VOC [b]	0.99	0.040	0.0013	0.68	0.12	0.0041	0.68	0.20	0.0069
PM_{10}	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
$PM_{2.5}$	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
Greenhouse Gases									
CO_2 [c]	188.2	7.59	0.26	188.2	33.31	1.12	188.2	56.59	1.91
CO_2e [e]	---	7.59	0.26	---	33.31	1.12	---	56.59	1.91

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC		
NOx	4.28	22.49
CO	1.43	7.51
VOC	0.36	1.92
PM_{10}	0.22	1.16
$PM_{2.5}$	0.22	1.16
Greenhouse Gases		
CO_2	97.50	512.02
CO_2e [e]	97.50	512.02

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor: 73.96 kg CO_2/mmBtu
393 hp-hr = mmBtu
188.2 g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

11. Drilling Tailpipe Emissions

Assumptions:

Number of deep gas wells drilled	156	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	1320	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	5	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{2000 \text{ (lb/ton)}}$$

Drilling Vehicles	**Heavy Haul Trucks-Deep Gas Wells**			**Heavy Duty Pickups-Deep Gas Wells**			**Total-Deep Gas Wells**[c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.39	0.25	7.39E-03	0.015	0.0101	0.40	41.25
CO	1.98E-02	0.10	0.068	7.26E-02	0.15	0.0993	0.25	26.04
VOC [c]	3.16E-03	0.016	0.011	3.54E-03	0.0073	0.0048	0.024	2.44
SO_2	4.57E-05	0.00024	0.00016	2.83E-05	0.000059	0.0000	0.00030	0.030
PM_{10}	4.22E-03	0.022	0.014	1.94E-04	0.00040	0.0003	0.022	2.29
$PM_{2.5}$	4.09E-03	0.021	0.014	1.79E-04	0.00037	0.0002	0.022	2.22
Greenhouse Gases								
CO_2	6.73E+00	34.86	23.00	1.61E+00	3.34	2.201	38.19	3932.16
CH_4	6.56E-05	0.00034	0.00022	2.08E-04	0.00043	0.0003	0.00077	0.079
N_2O	1.20E-05	0.000062	0.000041	8.05E-05	0.00017	0.0001	0.00023	0.024
CO_2e [d]	---	34.88	23.02	---	3.40	2.24	38.28	3941.14

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

12. Completion Tailpipe Emissions

Assumptions:

Number of deep gas wells	156	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks-Deep Gas Wells			Heavy Duty Pickups-Deep Gas Wells			Total-Deep Gas Wells [c]	
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/hr)	(tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.13	7.39E-03	0.015	0.004	0.48	21.46
CO	1.98E-02	0.12	0.04	7.26E-02	0.15	0.04	0.27	12.29
VOC [c]	3.16E-03	0.020	0.006	3.54E-03	0.007	0.0021	0.03	1.21
SO_2	4.57E-05	0.0003	0.00008	2.83E-05	0.00006	0.000017	0.0003	0.015
PM_{10}	4.22E-03	0.03	0.008	1.94E-04	0.0004	0.00012	0.03	1.20
$PM_{2.5}$	4.09E-03	0.03	0.007	1.79E-04	0.0004	0.00011	0.03	1.16
Greenhouse Gases								
CO_2	6.73E+00	41.83	12.05	1.61E+00	3.34	0.96	45.16	2029.05
CH_4	6.56E-05	0.0004	0.00012	2.08E-04	0.0004	0.00012	0.0008	0.04
N_2O	1.20E-05	0.00007	0.00002	8.05E-05	0.00017	0.00005	0.00024	0.011
CO_2e [d]	---	41.86	12.06	---	3.40	0.98	45.25	2033

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

KLEINFELDER	Project: GMBU - Alternative A -Gas Wells Date: 7/15/2013

13. Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	156	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.169	0.48
CO	1.98E-02	0.041	0.00074	7.26E-02	0.15	0.0027	0.19	0.54
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.014	0.039
SO_2	4.57E-05	0.00009	0.0000017	2.83E-05	0.000059	0.0000011	0.00015	0.00043
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00040	0.0000072	0.0091	0.026
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00037	0.0000067	0.0088	0.025
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	3.34	0.060	17.28	48.52
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00043	0.0000078	0.00057	0.0016
N_2O	1.20E-05	0.00002	0.0000004	8.05E-05	0.00017	0.0000030	0.00019	0.00054
CO_2e [d]	---	13.95	0.25	---	3.40	0.061	17.35	48.72

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

14. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation	1320	hours/deep gas well
Development Rate	156	deep gas wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

$$\text{Emissions (ton/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{horsepower (hp)} * \text{Hours (hour/year)} * \text{Load factor}}{\text{2000 lb/ton}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 , 10/96

Drill Rig Emissions (Tier 4)

Species	Drill Rig E. Factor (lb/hp-hr)	Drill Rig Emissions (lb/hr)	Gas Well Drill Rig Emissions (tons/yr-well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC				
NOx [a]	5.73E-03	5.21	3.44	536.44
CO [a]	5.73E-03	5.21	3.44	536.44
VOC [a]	3.09E-04	0.28	0.19	28.89
PM_{10} [a]	6.61E-05	0.06	0.04	6.19
$PM_{2.5}$ [a]	6.61E-05	0.06	0.04	6.19
SO_2 [b]	1.21E-05	0.011	0.0073	1.14
Hazardous Air Pollutants				
Benzene [c]	5.43E-06	0.0049	0.0033	0.51
Toluene [c]	1.97E-06	0.0018	0.0012	0.18
Xylenes [c]	1.35E-06	0.0012	0.00081	0.13
Formaldehyde [c]	5.52E-07	0.00050	0.00033	0.052
Acetaldehyde [c]	1.76E-07	0.00016	0.00011	0.017
Acrolein [c]	5.52E-08	0.00005	0.000033	0.0052
Naphthalene [d]	9.10E-07	0.00083	0.00055	0.085
POM 2 [d,e,f]	5.39E-07	0.00049	0.00032	0.050
POM 5 [d,e,g]	4.22E-09	0.0000038	0.0000025	0.00040
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000099	0.0015
POM 7 [d,e,i]	1.07E-08	0.000010	0.0000064	0.0010
Greenhouse Gases				
CO_2 [j]	1.14	1037.47	684.73	106,818
CH_4 [j,k]	4.63E-05	0.042	0.028	4.33
N_2O [j,k]	9.26E-06	0.0084	0.0056	0.87
CO_2e [m]	---	1040.96	687.03	107,177

a Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM) Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr

d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

i POM 7 includes: Chrysene.

j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

l Assumes maximum development scenario

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

15. Well Fracturing Engine

Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Typical frac engine horsepower	660	hp (deep gas wells)
Frac engine load factor	0.62	
Hours per frac job	60	hours/well (deep gas wells)
Development Rate - Deep Gas Wells	156	wells/year (deep gas wells)

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

Emissions (tons/year) = $\frac{\text{Emission Factor (lb/hp-hr) * Horsepower (hp)* Hours (hour/year) * Load Factor}}{\text{2000 lb/ton}}$

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

	Frac Engine Emissions				
Species	E. Factor (lb/MMBtu)	E. Factor (lb/hp-hr)	Gas Well Emissions (lb/hr)	Gas Well Emissions (tons/yr-well)	Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	3.2	0.024	9.82	0.29	45.96
CO [a]	0.85	5.50E-03	2.25	0.07	10.53
VOC [a]	0.09	7.05E-04	0.29	0.009	1.35
PM_{10} [a]	0.10	0.0007	0.29	0.009	1.34
$PM_{2.5}$ [a]	0.10	0.0007	0.29	0.009	1.34
SO_2 [a]	1.52E-03	1.21E-05	0.0050	0.00015	0.023
Hazardous Air Pollutants					
Benzene [b]	7.76E-04	5.43E-06	0.0022	0.000067	0.010
Toluene [b]	2.81E-04	1.97E-06	0.00080	0.000024	0.0038
Xylenes [b]	1.93E-04	1.35E-06	0.00055	0.000017	0.0026
Formaldehyde [b]	7.89E-05	5.52E-07	0.00023	0.0000068	0.0011
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000072	0.0000022	0.00034
Acrolein [b]	7.88E-06	5.52E-08	0.000023	0.00000068	0.00011
Naphthalene [c]	1.30E-04	9.10E-07	0.00037	0.000011	0.0017
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00022	0.0000066	0.0010
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000017	0.000000052	0.000008
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000068	0.00000020	0.000032
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000044	0.00000013	0.000021
Greenhouse Gases					
CO_2 [i]	163.05	1.14	753.3	22.60	3525.4
CH_4 [j]	6.61E-03	4.63E-05	0.031	0.00092	0.14
N_2O [j]	1.32E-03	9.26E-06	0.0061	0.00018	0.029
CO_2e [l]	---	---	755.8	22.7	3,537.3

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

16. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.191
Non-HC Wt. Fraction:	0.015
Total:	1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

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Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

17. Operations Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	261,747	miles/year-all wells
Operation Pickup Truck Mileage:	295,888	miles/year-all wells
Hours of Operation:	10	hours per day
Hours of Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total [d]**	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	3.84	7.01	6.05E-03	0.49	0.90	4.33	7.91
CO	1.02E-02	0.73	1.33	4.48E-02	3.63	6.63	4.36	7.96
VOC [c]	1.55E-03	0.11	0.20	1.61E-03	0.13	0.24	0.24	0.44
SO_2	3.07E-05	0.002	0.004	1.84E-05	0.0015	0.0027	0.004	0.007
PM_{10}	2.57E-03	0.18	0.34	1.31E-04	0.011	0.019	0.19	0.36
$PM_{2.5}$	2.50E-03	0.18	0.33	1.21E-04	0.010	0.018	0.19	0.35
Greenhouse Gases								
CO_2	4.520	324.1	591.5	1.050	85.1	155.3	409.3	746.9
CH_4	2.59E-05	0.0019	0.003	9.38E-05	0.008	0.014	0.009	0.017
N_2O	4.01E-06	0.0003	0.0005	2.68E-05	0.0022	0.0040	0.0025	0.004
CO_2e [c]	---	324.3	591.8	---	86.0	156.9	410.2	748.6

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

18. Operations Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of producing wells	2500	wells

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	29
Light Trucks	8,000	33
Mean Vehicle Weight	25,416	---
Total Round Trips	---	62

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-well**	**ton/year**
PM_{10}	1.33	1.17	0.061	0.098	244.60
$PM_{2.5}$	0.13	0.12	0.0061	0.0098	24.46

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-well**	**ton/year**
PM_{10}	0.018	0.018	0.00028	0.00052	1.29
$PM_{2.5}$	0.0045	0.0045	0.000069	0.000126	0.32

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

19. Gas Well Storage Tanks Working, Breathing, and Flashing Emissions

Assumptions:

Gas well production rate	2.0	barrels/day-well
Total Gas Wells	2500	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:
Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	**Tank Emissions (tons/yr-tank)**	**Controlled Tank Emissions (tons/yr-tank)**	**Total Wellsite Emissions [a] (tons/yr)**
VOC	0.71	0.00	1773.50
Hazardous Air Pollutants			
Benzene	0.0069	0.00	17.25
Toluene	0.012	0.00	28.75
Ethylbenzene	0.00050	0.00	1.25
Xylenes	0.0041	0.00	10.25
n-Hexane	0.018	0.00	45.50
Greenhouse Gases			
CO_2	0.14	0.00	358.3
CH_4	0.68	0.00	1698.3
CO_2e	14	0.00	36,022

a Total wellsite flashing emissions are based on 2500 uncontrolled tanks and 0 tanks controlled at 0%.

Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

20. Condensate Truck Loadout

Assumptions:

Deep Gas Well Condensate Production Rate	2.0	bbl/day-well
Number of Deep Gas Wells	2500	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (°R)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [b]
Condensate Loading [a]	0.6	5.2	66	520	4.94	2.0	0.076	189.22

	Condensate Loading tpy-well [c]	Condensate Loading tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.00074	1.84
Toluene	0.0012	3.07
Ethylbenzene	0.000053	0.13
Xylenes	0.00044	1.09
n-Hexane	0.0019	4.85
Greenhouse Gases		
CO2	0.015	38.22
CH4	0.072	181.19
CO2e	1.54	3843.3

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60°F.

b Assumes maximum development scenario

c Emissions estimated based on ratio of HAP/VOC in tank emissions

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Date: 7/15/2013

21. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.0546	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.0008	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.00520	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.00230	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.320

Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
2,500	306.08	1,079.17	9.45	22,672

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

22. Production Heater Emissions

Assumptions

Deep Gas Well Dehydrator Heater Size	750	Mbtu/hr
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Gas wells with dehydrators	2500	wells
Load Factor	0.6	load rate

Equations

Emissions (tons/yr) = AP-42 E.Factor (lbs/MMscf) * Fuel Consumption (MMscf/yr) * Fuel heating Value (Btu/scf) / 2,000 (lbs/ton) * 1,020 (Btu/scf - Standard Fuel Heating Value)

	Deep Gas Well Dehydrator Heater			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	100	0.044	0.19	110.29	483.09
CO [a]	84	0.037	0.16	92.65	405.79
VOC [b]	5.5	0.0024	0.011	6.07	26.57
SO_2 [b]	0.6	0.00026	0.0012	0.66	2.90
PM_{10} [b]	7.6	0.0034	0.015	8.38	36.71
$PM_{2.5}$ [b]	7.6	0.0034	0.015	8.38	36.71
Hazardous Air Pollutants					
Benzene [c]	2.10E-03	9.26E-07	4.06E-06	0.0023	0.010
Toluene [c]	3.40E-03	1.50E-06	6.57E-06	0.0038	0.016
Hexane [c]	1.80E+00	7.94E-04	3.48E-03	1.99	8.70
Formaldehyde [c]	7.50E-02	3.31E-05	1.45E-04	0.083	0.36
Dichlorobenzene [c]	1.20E-03	5.29E-07	2.32E-06	0.0013	0.0058
Naphthalene [c]	6.10E-04	2.69E-07	1.18E-06	0.00067	0.0029
POM 2 [c,d,e]	5.90E-05	2.60E-08	1.14E-07	0.000065	0.00029
POM 3 [c,f]	1.60E-05	7.06E-09	3.09E-08	0.000018	0.00008
POM 4 [c,g]	1.80E-06	7.94E-10	3.48E-09	0.000002	0.00001
POM 5 [c,h]	2.40E-06	1.06E-09	4.64E-09	0.000003	0.00001
POM 6 [c,i]	7.20E-06	3.18E-09	1.39E-08	0.000008	0.00003
POM 7 [c,j]	1.8E-06	7.94E-10	3.48E-09	0.000002	0.00001
Greenhouse Gases					
CO_2 [l]	119,226	52.60	230.39	131,499	575,965
CH_4 [l]	2.25	0.0010	0.0043	2.48	10.86
N_2O [l]	0.22	0.00010	0.00043	0.25	1.09
CO_2e [m]	---	52.65	230.61	131,628	576,530

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

23. Deep Gas Well Fugitive Emissions

Number of Producting Wells 2500 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.35
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.08
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.056
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.027
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.015
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.049
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	----
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
VOC EMISSIONS (tons/yr-well)						0.58
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**1452.70**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B

b Weight fractions from wellsite gas analysis and estimates

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction[b]	Liquid Weight Fraction of VOCs[b]	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	3.97
Toluene Emissions	0.0001	0.0162	5.20
Ethylbenzene Emissions	----	0.0007	0.20
Xylene Emissions	0.00001	0.0058	1.69
n-Hexane Emissions	0.0035	0.0257	28.85

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	49	8,760	0.84	0.0027	0.121	0.92	0.0081	19.36
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.0041	9.83
Open-Ended Lines - Gas	4	8,760	0.84	0.0027	0.031	0.019	0.00017	0.40
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						1.55	0.0135	32.53
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**3870.96**	**33.87**	**81324**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

24. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate:	0.4	MMscf/day/well
Wells Requiring Dehydrators:	2,500	wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95 % Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
VOC	0.0043	0.019	47.28
Hazardous Air Pollutants			
Benzene	0.00025	0.0011	2.75
Toluene	0.0011	0.0047	11.64
Ethylbenzene	0.00031	0.0014	3.41
Xylenes	0.0022	0.010	24.25
Greenhouse Gases			
CH_4	0.0068	0.030	73.98
CO_2e	0.14	0.62	1553.48

25. Wellsite Flare Emissions

Assumptions:

Number of gas well dehydrators with controls	2500	well pads
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [c] (lb/hr)	Total Emissions [c] (tons/yr)
Criteria Pollutants					
NOx [a]	0.068	0.002	0.01	4.59	20.09
CO [a]	0.37	0.01	0.04	24.96	109.31
Greenhouse Gases					
CO2 [b]	---	2.28	9.99	5,702	24,975
CH4 [b]	---	0.02	0.10	54.3	238.0
N2O [b]	---	0.00000	0.00002	0.0	0.042
CO2e [b]	---	2.74	11.99	6,846	29,986

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

26. Compressor Station Engines

Assumptions:

Number of new compressor stations	20	facilities
Number of expanded compressor stations	0	facilities
Compressor Engine Capacity	8000	hp

Equations:

Emission factor conversion:

g/hp-hr = AP-42 emission factor (lb/MMbtu) * 8000 Average BTU/hp-hr / 1,000,000 * 453.59 g/lb

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ g/lb} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions per Facility (lb/hr-facility)	Emissions per Facility (tons/yr-facility)	Emissions [i] Total (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	17.64	77.25	1544.97
CO [a]	-	2.0	35.27	154.50	3089.95
VOC [a]	-	0.7	12.35	54.07	1081.48
PM_{10} [b,c]	9.95E-03	0.036	0.64	2.79	55.77
$PM_{2.5}$ [b,c]	9.95E-03	0.036	0.64	2.79	55.77
SO_2 [b]	5.88E-04	0.002	0.04	0.16	3.30
Hazardous Air Pollutants [b]					
Benzene	4.40E-04	1.60E-03	0.014	0.062	1.23
Toluene	4.08E-04	1.48E-03	0.013	0.057	1.14
Ethylbenzene	3.97E-05	1.44E-04	0.0013	0.0056	0.11
Xylenes	1.84E-04	6.68E-04	0.0059	0.026	0.52
n-Hexane	1.11E-03	4.03E-03	0.036	0.16	3.11
Formaldehyde	5.28E-02	1.92E-01	1.69	7.40	148.01
Acetaldehyde	8.36E-03	3.03E-02	0.27	1.17	23.43
Acrolein	5.14E-03	1.87E-02	0.16	0.72	14.41
Methanol	2.50E-03	9.07E-03	0.080	0.35	7.01
1,1,2,2-Tetrachloroethane	4.00E-05	1.45E-04	0.0013	0.0056	0.11
1,1,2-Trichloroethane	3.18E-05	1.15E-04	0.0010	0.0045	0.089
1,3-Dichloropropene	2.64E-05	9.58E-05	0.00084	0.0037	0.074
1,3-Butadiene	2.67E-04	9.69E-04	0.0085	0.037	0.75
2,2,4-Trimethylpentane	2.50E-04	9.07E-04	0.0080	0.035	0.70
Biphenyl	2.12E-04	7.69E-04	0.0068	0.030	0.59
Carbon Tetrachloride	3.67E-05	1.33E-04	0.0012	0.0051	0.10
Chlorobenzene	3.04E-05	1.10E-04	0.0010	0.0043	0.085
Chloroform	2.85E-05	1.03E-04	0.00091	0.0040	0.080
Ethylene Dibromide	4.43E-05	1.61E-04	0.0014	0.0062	0.12
Methylene Chloride	2.00E-05	7.26E-05	0.00064	0.0028	0.056
Naphthalene	7.44E-05	2.70E-04	0.0024	0.010	0.21
Phenol	2.40E-05	8.71E-05	0.00077	0.0034	0.067
Styrene	2.36E-05	8.56E-05	0.00076	0.0033	0.066
Tetrachloroethane	2.48E-06	9.00E-06	0.000079	0.00035	0.0070
Vinyl Chloride	1.49E-05	5.41E-05	0.00048	0.0021	0.042
PAH -POM 1 [d,e]	2.69E-05	9.76E-05	0.00086	0.0038	0.075
POM 2 [d,f]	5.93E-05	2.15E-04	0.0019	0.0083	0.17
Benzo(b)fluoranthene/POM6	1.66E-07	6.02E-07	0.000005	0.000023	0.00047
Chrysene/POM7	6.93E-07	2.51E-06	0.000022	0.00010	0.0019
Greenhouse Gases					
CO_2 [g]	117	424	7,481	32,766	655,320
CH_4 [g]	0.002	0.0080	0.14	0.62	12.36
N_2O [g]	0.0002	0.00080	0.014	0.062	1.24
CO_2e [h]	---	---	7,488	32,798	655,963

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00, with 50% control from catalyst for HAPs

c PM = sum of PM filterable and PM condensable

d Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP-42 Table 1.4-3 footnotes.

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

h Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

i Assumes maximum development scenario

27. Compressor Station Condensate Tanks

Assumptions:

Average Condensate Production Rate :

Facility Production Rate	73.5	bbls per day per facility
Tank Control Efficiency	95	%
Total Facilities	20	Compressor Stations
Number of Tanks at Comp Station	4	tanks/facility

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS
Controlled by combustion device with 95% efficiency

Component	Tank Emissions (tons/yr/Tank)	Controlled Tank Emissions (tons/yr/Tank)	Total[a] Emissions (tons/yr)
Total VOC	6.52	0.33	26.07
Hazardous Air Pollutants			
Benzene	0.063	0.0032	0.254
Toluene	0.11	0.0053	0.423
Ethylbenzene	0.0046	0.00023	0.0184
Xylenes	0.038	0.0019	0.151
n-Hexane	0.17	0.0084	0.67
Greenhouse Gases			
CO_2	1.32	1.32	105.33
CH_4	6.24	0.31	24.96
CO_2e	132	7.87	629.6

a Assumes maximum development scenario

28. Compressor Station Dehydrator Emissions

Assumptions

Number of Compressor Stations 20 Stations
Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69	233.83
Hazardous Air Pollutants			
Benzene	0.13	0.56	11.20
Toluene	0.090	0.39	7.88
Ethylbenzene	---	---	---
Xylenes	0.016	0.070	1.41
n-Hexane	0.078	0.34	6.79
Greenhouse Gases			
CH_4	3.28	14.35	287.02
CO_2e	68.81	301.38	6027.50

a Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: GMBU - Alternative A -Gas Wells Date: 7/15/2013

29. Compressor Station Truck Loadout

Assumptions:		
Facility Production Rate	74	bbls per day per facility
Total Facilities	20	

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility	tpy[b]
12.46	0.6	5.2	66	520	4.94	74	2.78	55.63

	tpy-facility[c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.027	0.54
Toluene	0.045	0.90
Ethylbenzene	0.0020	0.039
Xylenes	0.016	0.32
n-Hexane	0.071	1.43
Greenhouse Gases		
CO2	0.56	11.24
CH4	2.664	53.27
CO2e	56.50	1129.92

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60^{o} F.

b Emission for full buildout

c Emissions estimated based on condensate tank analysis

Project: GMBU - Alternative A -Gas Wells

Date: 7/15/2013

30. Compressor Station Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	51,302	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{2000 \text{ (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.75	1.37	6.05E-03	0.00	0.00	0.75	1.37
CO	1.02E-02	0.14	0.26	4.48E-02	0.00	0.00	0.14	0.26
VOC [c]	1.55E-03	0.022	0.040	1.61E-03	0.00	0.00	0.022	0.040
SO_2	3.07E-05	0.0004	0.001	1.84E-05	0.00	0.00	0.0004	0.0008
PM_{10}	2.57E-03	0.036	0.066	1.31E-04	0.00	0.00	0.036	0.066
$PM_{2.5}$	2.50E-03	0.035	0.064	1.21E-04	0.00	0.00	0.035	0.064
Greenhouse Gases								
CO_2	4.520	63.5	115.9	1.050	0.0	0.0	63.5	115.9
CH_4	2.59E-05	0.0004	0.001	9.38E-05	0.00	0.00	0.0004	0.001
N_2O	4.01E-06	0.0001	0.0001	2.68E-05	0.00	0.00	0.0001	0.0001
CO_2e [c]	---	63.6	116.0	---	0.0	0.0	63.6	116.0

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: GMBU - Alternative A -Gas Wells Date: 7/15/2013

31. Compressor Station Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of Compressor Stations	20	facilities

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	0.96	1.54	30.80
$PM_{2.5}$	0.17	0.15	0.096	0.15	3.08

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	6
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	6

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.0062	0.0112	0.22
$PM_{2.5}$	0.0081	0.0081	0.0015	0.0028	0.055

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

32. Compressor Station Fugitive Emissions

Number of Compressor Stations 20 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	114	8,760	0.19	4.50E-03	9.95E-03	0.95
Valves - Light Oil	28	8,760	0.41	2.50E-03	5.53E-03	0.28
Valves - Heavy Oil	0	8,760	0.41	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	28	8,760	0.41	9.80E-05	2.17E-04	0.011
Connectors - Gas	520	8,760	0.19	2.00E-04	4.42E-04	0.19
Connectors - Light Oil	44	8,760	0.41	2.10E-04	4.64E-04	0.04
Connectors - Heavy Oil	0	8,760	0.41	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	45	8,760	0.41	1.10E-04	2.43E-04	0.020
Open-Ended Lines - Gas	2	8,760	0.19	2.00E-03	4.42E-03	0.0074
Open-Ended Lines - Light Oil	0	8,760	0.41	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.41	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.41	2.50E-04	5.53E-04	---
Flanges - Gas	72	8,760	0.19	3.90E-04	8.62E-04	0.052
Flanges - Light Oil	0	8,760	0.41	1.10E-04	2.43E-04	---
Flanges - Heavy Oil	0	8,760	0.41	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	0	8,760	0.41	2.90E-06	6.41E-06	---
Other - Gas	91	8,760	0.19	8.80E-03	1.94E-02	1.48
Other - Light Oil	0	8,760	0.41	7.50E-03	1.66E-02	---
Other - Heavy Oil	0	8,760	0.41	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	0	8,760	0.41	1.40E-02	3.09E-02	---
Compressor station VOC Emissions (tons/yr)						**3.03**
Total Compressor station VOC Emissions (tons/yr)[d]						**60.55**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components referenced from similar existing facilities
b VOC and HAP weight fractions from wellsite gas analysis and compressor tank emissions
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Liquid Weight Fraction of VOCs	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.124
Toluene Emissions	0.0001	0.016	0.141
Ethylbenzene Emissions	----	0.00070	0.005
Xylene Emissions	0.00001	0.0058	0.043
n-Hexane Emissions	0.0035	0.026	1.17

32. Compressor Station Fugitive Emissions

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	170	8,760	0.84	0.0027	0.121	3.20	0.028	67.17
Connectors - Gas	609	8,760	0.84	0.0027	0.017	1.61	0.014	33.81
Open-Ended Lines - Gas	2	8,760	0.84	0.0027	0.031	0.010	0.000084	0.20
Flanges - Light Oil	72	8,760	0.84	0.0027	0.003	0.034	0.00029	0.71
Other - Light Oil	91	8,760	0.84	0.0027	0.3	4.24	0.037	89.14
Compressor station GHG Emissions (tons/yr)						**9.09**	**0.080**	**191.0**
Total Compressor station GHG Emissions (tons/yr)[d]						**181.85**	**1.591**	**3820.5**

a Number of components referenced from similar existing facilities

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

33. Gas Processing Plant Compression

Assumptions:

Number of compressors	4	engines
Compressor horsepower	300	hp/engine

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}*8760 \text{ (hr/yr)}}{453.6 \text{ (g/lb)}*2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (ton/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	0.66	2.90	11.59
CO [a]	-	2.0	1.32	5.79	23.17
VOC [a]	-	0.7	0.46	2.03	8.11
PM_{10} [b,d]	1.94E-02	7.92E-02	0.052	0.23	0.92
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.052	0.23	0.92
SO_2 [b]	5.88E-04	2.40E-03	0.0016	0.007	0.028
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.0021	0.0093	0.037
Toluene	5.58E-04	2.28E-03	0.00075	0.0033	0.013
Ethylbenzene	2.48E-05	1.01E-04	0.000033	0.00015	0.00059
Xylenes	1.95E-04	7.96E-04	0.00026	0.0012	0.0046
Formaldehyde	2.05E-02	8.37E-02	0.028	0.12	0.48
Acetaldehyde	2.79E-03	1.14E-02	0.0038	0.016	0.066
Acrolein	2.63E-03	1.07E-02	0.0036	0.016	0.062
Methanol	3.06E-03	1.25E-02	0.0041	0.018	0.072
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.000034	0.00015	0.00060
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.000021	0.000090	0.00036
1,3-Dichloropropene	1.27E-05	5.18E-05	0.000017	0.000075	0.00030
1,3-Butadiene	6.63E-04	2.71E-03	0.00090	0.0039	0.016
Carbon Tetrachloride	1.77E-05	7.23E-05	0.000024	0.00010	0.00042
Chlorobenzene	1.29E-05	5.27E-05	0.000017	0.000076	0.00031
Chloroform	1.37E-05	5.59E-05	0.000018	0.000081	0.00032
Ethylene Dibromide	2.13E-05	8.70E-05	0.000029	0.00013	0.00050
Methylene Chloride	4.12E-05	1.68E-04	0.000056	0.00024	0.0010
Naphthalene	9.71E-05	3.96E-04	0.00013	0.00057	0.0023
Styrene	1.19E-05	4.86E-05	0.000016	0.000070	0.00028
Vinyl Chloride	7.18E-06	2.93E-05	0.000010	0.000042	0.00017
PAH -POM 1	1.41E-04	5.76E-04	0.00019	0.00083	0.0033
Greenhouse Gases					
CO_2 [e]	117	477.2	315.59	1382	5529.1
CH_4 [e]	0.002	9.00E-03	0.0060	0.026	0.10
N_2O [e]	0.0002	9.00E-04	0.00060	0.003	0.010
CO_2e [f]	---	---	315.9	1384	5535

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

34. Gas Processing Plant Dehydrator Emissions

Assumptions

Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69
Hazardous Air Pollutants		
Benzene	0.13	0.56
Toluene	0.090	0.39
Ethylbenzene	---	---
Xylenes	0.016	0.070
n-Hexane	0.078	0.34
Greenhouse Gases		
CH_4	3.28	14.35
CO_2e	68.81	301.38

a Assumes maximum development scenario

35. Gas Processing Plant Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	72	8,760	0.19	4.50E-03	9.95E-03	0.60
Connectors - Gas	247	8,760	0.19	2.00E-04	4.42E-04	0.091
Open-Ended Lines - Gas	9	8,760	0.19	2.00E-03	4.42E-03	0.033
Other - Gas	5	8,760	0.19	8.80E-03	1.94E-02	0.081
Total Gas Processing Plant VOC Emissions (tons/yr)[d]						**0.81**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.00086
Toluene Emissions	0.00011	0.00045
Ethylbenzene Emissions	----	----
Xylene Emissions	0.000011	0.000045
n-Hexane Emissions	0.0035	0.015

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	72	8,760	0.84	0.0027	0.121	1.35	0.012	28.45
Connectors - Gas	247	8,760	0.84	0.0027	0.017	0.65	0.0057	13.71
Open-Ended Lines - Gas	9	8,760	0.84	0.0027	0.031	0.043	0.00038	0.91
Other	5	8,760	0.84	0.0027	0.3	0.23	0.0020	4.90
Total Gas Processing Plant GHG Emissions (tons/yr)[d]						**2.05**	**0.018**	**43.07**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

36. Central Facility Heater Emissions

Assumptions

Gas Processing Dehydrator Reboiler Size	1,500	Mbtu/hr
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
	1	Gas Processing Plant
	20	Compressor Station

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Compressor Station Reboiler			Gas Processing Plant Reboiler			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.15	0.64	100	0.15	0.64	3.09	13.53
CO [a]	84	0.12	0.54	84	0.12	0.54	2.59	11.36
VOC [b]	5.5	0.008	0.035	5.5	0.008	0.035	0.17	0.74
SO_2 [b]	0.6	0.001	0.0039	0.6	0.001	0.0039	0.019	0.081
PM_{10} [b]	7.6	0.011	0.049	7.6	0.011	0.049	0.23	1.03
$PM_{2.5}$ [b]	7.6	0.011	0.049	7.6	0.011	0.049	0.23	1.03
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	3.09E-06	1.35E-05	2.10E-03	3.09E-06	1.35E-05	0.000065	0.00028
Toluene [c]	3.40E-03	5.00E-06	2.19E-05	3.40E-03	5.00E-06	2.19E-05	0.00011	0.00046
Hexane [c]	1.80E+00	2.65E-03	1.16E-02	1.80E+00	2.65E-03	1.16E-02	0.056	0.24
Formaldehyde [c]	7.50E-02	1.10E-04	4.83E-04	7.50E-02	1.10E-04	4.83E-04	0.0023	0.010
Dichlorobenzene [c]	1.2E-03	1.76E-06	7.73E-06	1.2E-03	1.76E-06	7.73E-06	0.000037	0.00016
Naphthalene [c]	6.1E-04	8.97E-07	3.93E-06	6.1E-04	8.97E-07	3.93E-06	0.000019	0.000083
POM 2 [c,d,e]	5.9E-05	8.68E-08	3.80E-07	5.9E-05	8.68E-08	3.80E-07	0.000002	0.000008
POM 3 [c,f]	1.6E-05	2.35E-08	1.03E-07	1.6E-05	2.35E-08	1.03E-07	0.0000005	0.000002
POM 4 [c,g]	1.8E-06	2.65E-09	1.16E-08	1.8E-06	2.65E-09	1.16E-08	0.0000001	0.0000002
POM 5 [c,h]	2.4E-06	3.53E-09	1.55E-08	2.4E-06	3.53E-09	1.55E-08	0.0000001	0.0000003
POM 6 [c,i]	7.2E-06	1.06E-08	4.64E-08	7.2E-06	1.06E-08	4.64E-08	0.0000002	0.000001
POM 7 [c,j]	1.8E-06	2.65E-09	1.16E-08	1.8E-06	2.65E-09	1.16E-08	0.0000001	0.0000002
Greenhouse Gases								
CO_2 [l]	119,226	175.3	768.0	119,226	175.3	768.0	3,682	16,127
CH_4 [l]	2.25	0.0033	0.014	2.25	0.0033	0.014	0.07	0.30
N_2O [l]	0.22	0.0003	0.001	0.22	0.0003	0.001	0.01	0.03
CO_2e [m]	---	175.5	768.7	---	175.5	768.7	3,686	16,143

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

37. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations 20
Number of Gas Processing Plants 1

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-flare)	Total Emissions (tons/yr-flare)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	18.76
CO [a]	0.37	1.11	4.86	102.10
Greenhouse Gases				
CO2 [b]	---	402	1,759	36,935
CH4 [b]	---	3.83	16.76	352.0
N2O [b]	---	0.0007	0.003	0.062
CO2e [b]	---	482	2,112	44,345

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

50 MMscfd

Calculated Absorber Stages:	2.51
Specified Dry Gas Dew Point:	5.00 lbs. H2O/MMSCF
Temperature:	125.0 deg. F
Pressure:	800.0 psig
Dry Gas Flow Rate:	50.0000 MMSCF/day
Glycol Losses with Dry Gas:	1.8232 lb/hr
Wet Gas Water Content:	Saturated
Calculated Wet Gas Water Content:	137.42 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

50 MMscfd		
2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

50 MMscfd

Flow Rate: 1.46e+001 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

50 MMscfd

Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX B

PROPOSED ACTION ANNUAL DEVELOPMENT EMISSIONS

APPENDIX B-1

MONUMENT BUTTE PROJECT AREA EMISSIONS AS OF DECEMBER 31, 2011

	Source ID	December 31, 2011 Emissions (tpy) [a] NOx	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	---	---	---
	Drilling Tailpipe	---	---	---
	Drilling - Rigs	---	---	---
	Completion Tailpipe	---	---	---
	Completion Rigs	---	---	---
	Completion Venting	---	---	---
	Interim Reclamation Tailpipe	---	---	---
Production Emissions	Pump Unit Engines	1,035.2	301.7	1,336.9
	Production Heaters	305.8	161.3	467.2
	Wellsite Tanks - W&B	0.0	1,323.6	1,323.6
	Wellsite Tanks - Flashing	0.0	1,345.0	1,345.0
	Wellsite Truck Loading	0.0	213.5	213.5
	Wellsite Flares	0.0	0.0	0.0
	Wellsite Fugitives	0.0	437.5	437.5
	Wellsite Pneumatics	0.0	145.3	145.3
	Operations Vehicle	19.9	0.7	20.5
	Infrastructure	202.0	57.0	259.0
	Total Emissions	**1,563**	**3,986**	**5,549**

a Emissions in summary tables may vary slightly due to rounding differences.

KLEINFELDER
Bright People. Right Solutions.

Project: Greater Monument Butte Unit 12/31/2011 Emissions
Date: 4/26/2013

Operations Tailpipe Emissions

Assumptions:

Total Annual New Pumper Mileage:	725,912	miles/year
Total Annual Pickup Mileage:	136,109	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	**Heavy Duty Pickups**			**Heavy Haul Trucks**			**Total**
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.23	0.41	5.36E-02	10.66	19.45	19.87
VOC	1.61E-03	0.06	0.11	1.55E-03	0.31	0.56	0.67

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2011 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.79
VOC Wt. Fraction:	0.19
Non-HC Wt. Fraction:	0.02
Total:	1.00

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Percent	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	67.41	1,010	847	910	763
Ethane	7.944	30.07	2.389	11.97	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	9.53	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	2.00	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	3.74	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	1.20	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	1.35	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.58	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.27	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.049	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0051	6,996	0.06	0.00	0.00
Decanes	0.000	142.29	0.000	0.0007	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.020	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.011	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.0002	106.16	0.000	0.001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.35	4,756	3.89	0.00	0.00
Nitrogen	0.647	28.01	0.181	0.91	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.59	0.00	0.00	0.00	0.00
Hydrogen Sulfide	0.005	34.08	0.002	0.01	637	0.03	588	0.03
Total	**100.0**	-	**20.0**	**100.0**	-	**1,203**	-	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2011 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	13,833	bbls oil per day-all wells
Number of Well Pads with Tanks:	1187	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	0	well pads
Control Efficiency of tanks:	0	%
Average Throughput:	89,325	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.56	0.00	1323.59

a Total wellsite working and breathing emissions are based on 2374 uncontrolled tanks and 0 tanks controlled at 0%.

KLEINFELDER

Project: Greater Monument Butte Unit 12/31/2011 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	13833	bbl/day-all wells
Number of Well Pads with Tanks:	1187	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	0	well pads
Control Efficiency of tanks:	0	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 107.34 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	41.75	322.05
Ethane	30.07	16.516	4.97	0.132	17.73	256.37
Propane	44.10	16.909	7.46	0.198	18.15	384.94
i-Butane	58.12	3.694	2.15	0.057	3.97	110.83
n-Butane	58.12	9.044	5.26	0.140	9.71	271.35
i-Pentane	72.15	3.269	2.36	0.063	3.51	121.76
n-Pentane	72.15	4.297	3.10	0.082	4.61	160.04
Cyclopentane	70.10	0.361	0.25	0.007	0.39	13.06
Hexanes	86.18	2.285	1.97	0.052	2.45	101.66
Heptanes	100.20	1.423	1.43	0.038	1.53	73.61
Octanes	114.23	0.403	0.46	0.012	0.43	23.76
Nonanes	128.26	0.076	0.10	0.003	0.08	5.03
Decanes +	142.29	0.026	0.04	0.001	0.03	1.91
Benzene	78.11	0.106	0.08	0.002	0.11	4.27
Toluene	92.14	0.083	0.08	0.002	0.09	3.95
Ethylbenzene	106.17	0.004	0.00	0.000	0.00	0.22
Xylenes	106.17	0.023	0.02	0.001	0.02	1.26
n-Hexane	86.18	1.513	1.30	0.035	1.62	67.31
Nitrogen	28.01	0.612	0.17	0.005	0.66	8.85
Carbon Dioxide	44.01	0.460	0.20	0.005	0.49	10.45
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**46.71**	**1344.96**
HAP SUBTOTAL		**1.73**	**1.49**	**0.04**	**1.86**	**77.01**
TOTAL		**100.00**	**37.63**	**1.00**	**107.34**	**1942.68**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1344.96	0.00	1344.96

a Total wellsite flashing emissions are based on 2374 uncontrolled tanks and 0 tanks controlled at 0%.

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2011 Emissions Date: 4/26/2013

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 13,832.9 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	13832.9	213.55

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60 ^{o}F.

b Assumes maximum development scenario

KLEINFELDER
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Project: Greater Monument Butte Unit 1
Date: 4/26/2013

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	369	engines
Number of Ajax Engines	818	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6\ \text{g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	868.9
VOC	1.3	0.31	256.7

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	166.3
VOC [c]	0.51	0.12	45.0

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2011 Emissions Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.177	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.204	0.055	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.231	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.258	0.0008	0.0010	0.005	0.000011	0.0000038	0.00002
Decanes +	142.285	0.0001	0.0001	0.001	0.0000014	0.00000052	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.0023	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.001	0.000003	0.0000008	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.013	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.001	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.320

	Number of Wells	VOC emissions (tons/year)
Proposed Action	1,187	145.33

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2011 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producing Wells 1187 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	---
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**437.55**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Project: Greater Monument Butte Unit 12/31/2011 Emissions
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Number of wells with heater treater	1187	wells
Number of wellpads with tanks	1187	wells
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NO_x [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	305.83
VOC [b]	5.5	0.002	0.007	5.5	0.002	0.007	5.5	0.000	0.000	161.32

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification		
User Identification:	GMB Unit 12/31/11 Tanks	
City:	Duchesne	
State:	Utah	
Company:	Newfield Exploration	
Type of Tank:	Vertical Fixed Roof Tank	
Description:	One (1) 400 bbl Storage Tank	
Tank Dimensions		
Shell Height (ft):		20.00
Diameter (ft):		12.00
Liquid Height (ft) :		19.00
Avg. Liquid Height (ft):		10.00
Volume (gallons):		16,074.56
Turnovers:		5.56
Net Throughput(gal/yr):		89,325.00
Is Tank Heated (y/n):	N	
Paint Characteristics		
Shell Color/Shade:	Gray/Light	
Shell Condition	Good	
Roof Color/Shade:	Gray/Light	
Roof Condition:	Good	
Roof Characteristics		
Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00
Breather Vent Settings		
Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMB Unit 12/31/11 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMB Unit 12/31/11 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations	
Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	233.6974
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	89,325.0000
Annual Turnovers:	5.5569
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,115.0711

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMB Unit 12/31/11 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	233.70	881.37	1,115.07

APPENDIX B-2
PROPOSED ACTION DEVELOPMENT FOR 2012

	Source ID	December 31, 2012 Emissions (tpy) [a] NO$_X$	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.3	0.6	8.0
	Drilling Tailpipe	3.0	0.2	3.2
	Drilling - Rigs	57.7	12.0	69.7
	Completion Tailpipe	11.7	0.9	12.6
	Completion Rigs	23.2	0.7	23.9
	Completion Venting	0.0	4.7	4.7
	Interim Reclamation Tailpipe	0.6	0.0	0.6
Production Emissions	Pump Unit Engines	898.5	259.1	1,157.6
	Production Heaters	283.5	140.6	424.2
	Wellsite Tanks - W&B	0.0	1,215.4	1,215.4
	Wellsite Tanks - Flashing	0.0	1,504.0	1,504.0
	Wellsite Truck Loading	0.0	238.8	238.8
	Wellsite Flares	0.0	0.0	0.0
	Wellsite Fugitives	0.0	432.8	432.8
	Wellsite Pneumatics	0.0	143.7	143.7
	Operations Vehicle	22.0	0.7	22.7
	Infrastructure	202.0	57.0	259.0
	Total Emissions	**1,510**	**4,011**	**5,521**

a Emissions in summary tables may vary slightly due to rounding differences.

Construction Tailpipe Emissions

Assumptions:

Number of new wells	187	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.62
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.071

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2012 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2012 Emissions Date: 4/26/2013

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	187	
Average Round Trip Distance	24.9	miles
Hours of Operation	64	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{2000 \text{ (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.462	0.015	7.39E-03	0.038	0.0012	3.00
VOC	3.16E-03	0.020	0.00063	3.54E-03	0.018	0.00059	0.23

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2012 Emissions
Date: 4/26/2013

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	187	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	11.74
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.87

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2012 Emissions Date: 4/26/2013

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	187	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total [c]**
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.57
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.047

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2012 Emissions
Date: 4/26/2013

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	2	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 0 drill rigs	0	%
Percent of Tier 2 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{2000 \text{ (lb/ton)}}$$

	Drill Rig Emissions (Tier 0)		
Species	Drill Rig E. Factor [a]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	2.40E-02	21.82	0.00
VOC	6.42E-04	0.58	0.00

	Drill Rig Emissions (Tier 2)		
Species	Drill Rig E. Factor [b]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	1.06E-02	9.62	57.71
VOC	2.20E-03	2.00	12.02

a AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96

b Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2012 Emissions
Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	187	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions E. Factor (lb/MMBtu)	Emissions (lb/hr)	Emissions (tons/yr)	Totals Emissions [c] (tons/yr)
NOx	3.2	9.84	0.12	23.21
VOC [b]	0.090	0.28	0.0035	0.65

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2012 Emissions
Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	187	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	16.57
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	2.94
Propane	44.1	4.313	1.902	0.095	0.216	0.013	2.34
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.49
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	0.92
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.30
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.33
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.14
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.067
Octanes	114	0.009	0.010	0.0005	0.0004	0.0001	0.012
Nonanes	128	0.001	0.001	0.0001	0.00004	0.00001	0.0013
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00018
Benzene	78.1	0.005	0.004	0.0002	0.0003	0.00003	0.0050
Toluene	92.1	0.002	0.002	0.0001	0.0001	0.00001	0.0026
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00026
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.087
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.22
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.15
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0021
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**4.70**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.095**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**24.59**

a Assumes full development scenario

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Project: Greater Monument Butte Unit 12/31/2012 Emissions
Date: 4/26/2013

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	807,577	miles/year
Total Annual Pickup Mileage:	117,961	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	**Heavy Duty Pickups**			**Heavy Haul Trucks**			**Total**
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.20	0.36	5.36E-02	11.86	21.64	22.00
VOC	1.61E-03	0.052	0.09	1.55E-03	0.34	0.63	0.72

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

KLEINFELDER

Project: Greater Monument Butte Unit 12/31/2012 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet):	1181.9	Btu/scf
C1-C2 Wt. Fraction:	0.794	
VOC Wt. Fraction:	0.191	
Non-HC Wt. Fraction:	0.015	
Total:	1.000	

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2012 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	15,468	bbls oil per day-all wells
Number of Well Pads with Tanks:	1027	well pads
Tanks per wellsite:	2	tanks
Number of Well Pads with Controls:	0	well pads
Control Efficiency of tanks:	0	%
Average Throughput:	115,448	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.59	0.000	1215.37

a Total wellsite working and breathing emissions are based on 2054 uncontrolled tanks and 0 tanks controlled at 0%.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2012 Emissions Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	15468	bbl/day-all wells
Number of Well Pads with Tanks:	1027	well pads
Tanks per wellsite:	2	tanks
Number of Well Pads with Controls:	0	well pads
Control Efficiency of tanks:	0	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 120.03 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	46.69	360.13
Ethane	30.07	16.516	4.97	0.132	19.82	286.69
Propane	44.10	16.909	7.46	0.198	20.30	430.45
i-Butane	58.12	3.694	2.15	0.057	4.43	123.93
n-Butane	58.12	9.044	5.26	0.140	10.86	303.43
i-Pentane	72.15	3.269	2.36	0.063	3.92	136.15
n-Pentane	72.15	4.297	3.10	0.082	5.16	178.97
Cyclopentane	70.10	0.361	0.25	0.007	0.43	14.61
Hexanes	86.18	2.285	1.97	0.052	2.74	113.67
Heptanes	100.20	1.423	1.43	0.038	1.71	82.31
Octanes	114.23	0.403	0.46	0.012	0.48	26.57
Nonanes	128.26	0.076	0.10	0.003	0.09	5.63
Decanes +	142.29	0.026	0.04	0.001	0.03	2.14
Benzene	78.11	0.106	0.08	0.002	0.13	4.78
Toluene	92.14	0.083	0.08	0.002	0.10	4.41
Ethylbenzene	106.17	0.004	0.00	0.000	0.00	0.25
Xylenes	106.17	0.023	0.02	0.001	0.03	1.41
n-Hexane	86.18	1.513	1.30	0.035	1.82	75.27
Nitrogen	28.01	0.612	0.17	0.005	0.73	9.90
Carbon Dioxide	44.01	0.460	0.20	0.005	0.55	11.69
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**52.23**	**1503.98**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**2.08**	**86.12**
TOTAL		**100.00**	**37.63**	**1.00**	**120.03**	**2172.38**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1503.98	0.00	1503.98

a Total wellsite flashing emissions are based on 2054 uncontrolled tanks and 0 tanks controlled at 0%.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2012 Emissions Date: 4/26/2013

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 15,468.4 bbl/day-all wells

AP - 42, Chapter 5.2 L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	15468.4	238.80

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60^{o}F.
b Assumes maximum development scenario

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Project: Greater Monument Butte Unit 1:
Date: 4/26/2013

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	570	engines
Number of Ajax Engines	604	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	641.6
VOC	1.3	0.31	189.5

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	256.9
VOC [c]	0.51	0.12	69.6

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1174	143.73

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2012 Emissions Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1174 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**432.75**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C

b VOC weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2012 Emissions Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	heater treaters
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Number of wells with heater treaters	1174	wells
Number of wellpads with tanks	1027	well pads
Tanks per wellsite	2	new tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	283.54
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	140.62

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	0	well pads
Number of wellpads with tanks	1027	well pads
Tank vent gas to flares	0.00	scf/hr
Heating Value of Combusted Gas	2100	Btu/scf
Heat Rating	0.00	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.00	0.00

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification	
User Identification:	GMB 12/31/2012 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank
Tank Dimensions	
Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	7.18
Net Throughput(gal/yr):	115,448.00
Is Tank Heated (y/n):	N
Paint Characteristics	
Shell Color/Shade:	Gray/Light
Shell Condition	Good
Roof Color/Shade:	Gray/Light
Roof Condition:	Good
Roof Characteristics	
Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00
Breather Vent Settings	
Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMB 12/31/2012 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMB 12/31/2012 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	302.0420
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	115,448.0000
Annual Turnovers:	7.1820
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,183.4156

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMB 12/31/2012 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	302.04	881.37	1,183.42

APPENDIX B-3

PROPOSED ACTION DEVELOPMENT FOR 2013

KLEINFELDER
Bright People. Right Solutions.

Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

	Source ID	December 31, 2013 Emissions (tpy) [a]		
		NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.3	0.6	7.9
	Drilling Tailpipe	3.8	0.3	4.0
	Drilling - Rigs	72.1	15.0	87.2
	Completion Tailpipe	11.0	0.8	11.9
	Completion Rigs	21.8	0.6	22.5
	Completion Venting	0.0	4.4	4.4
	Interim Reclamation Tailpipe	0.5	0.0	0.6
Production Emissions	Pump Unit Engines	765.4	217.8	983.2
	Production Heaters	255.2	124.9	380.1
	Wellsite Tanks - W&B	0.0	917.9	917.9
	Wellsite Tanks - Flashing	0.0	1,202.8	1,202.8
	Wellsite Truck Loading	0.0	228.9	228.9
	Wellsite Flares	0.9	0.0	0.9
	Wellsite Fugitives	0.0	423.9	423.9
	Wellsite Pneumatics	0.0	140.8	140.8
	Operations Vehicle	21.2	0.7	21.9
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**1,391**	**3,383**	**4,774**

a Emissions in summary tables may vary slightly due to rounding differences.

Construction Tailpipe Emissions

Assumptions:

Number of new wells	176	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{2000 \text{ (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/pad)	(lb/mile)	(lb/hr)	(tons/yr/pad)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.59
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.067

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	176	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	85	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{2000 \text{ (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.462	0.020	7.39E-03	0.038	0.0016	3.76
VOC	3.16E-03	0.020	0.00084	3.54E-03	0.018	0.00078	0.28

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	176	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	11.05
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.81

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2013 Emissions Date: 4/26/2013

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	176	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{2000 \text{ (lb/ton)}}$$

Interim Rec Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total [c]**
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.54
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.044

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	2.5	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 0 drill rigs	0	%
Percent of Tier 2 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr) * Rated Horsepower (hp)* Operating Hours (hrs) * Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 0)		
Species	Drill Rig E. Factor [a]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	2.40E-02	21.82	0.00
VOC	6.42E-04	0.58	0.00

	Drill Rig Emissions (Tier 2)		
Species	Drill Rig E. Factor [b]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	1.06E-02	9.62	72.14
VOC	2.20E-03	2.00	15.03

a AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96
b Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used
c Assumes maximum development scenario

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	176	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions			Totals
	E. Factor (lb/MMBtu)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [c] (tons/yr)
NOx	3.2	9.84	0.12	21.84
VOC [b]	0.090	0.28	0.0035	0.61

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	176	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	15.60
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	2.77
Propane	44.1	4.313	1.902	0.095	0.216	0.013	2.20
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.46
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	0.87
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.28
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.31
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.13
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.063
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.011
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0012
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00016
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0047
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0025
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00025
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.082
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.21
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.14
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0020
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**4.42**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.089**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**23.14**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	780,355	miles/year
Total Annual Pickup Mileage:	108,887	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.18	0.33	5.36E-02	11.46	20.91	21.24
VOC	1.61E-03	0.048	0.09	1.55E-03	0.33	0.60	0.69

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

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Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet):	1181.9	Btu/scf
C1-C2 Wt. Fraction:	0.794	
VOC Wt. Fraction:	0.191	
Non-HC Wt. Fraction:	0.015	
Total:	1.000	

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

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Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	14,830	bbls oil per day-all wells
Number of Well Pads with Tanks:	911	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	159	well pads
Control Efficiency of tanks:	95	%
Average Throughput:	124,779	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.60	0.030	917.89

a Total wellsite working and breathing emissions are based on 1504 uncontrolled tanks and 318 tanks controlled at 95%.

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Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	14830	bbl/day-all wells
Number of Well Pads with Tanks:	911	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	159	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 115.08 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	44.76	345.27
Ethane	30.07	16.516	4.97	0.132	19.01	274.86
Propane	44.10	16.909	7.46	0.198	19.46	412.69
i-Butane	58.12	3.694	2.15	0.057	4.25	118.82
n-Butane	58.12	9.044	5.26	0.140	10.41	290.91
i-Pentane	72.15	3.269	2.36	0.063	3.76	130.53
n-Pentane	72.15	4.297	3.10	0.082	4.95	171.58
Cyclopentane	70.10	0.361	0.25	0.007	0.42	14.01
Hexanes	86.18	2.285	1.97	0.052	2.63	108.98
Heptanes	100.20	1.423	1.43	0.038	1.64	78.91
Octanes	114.23	0.403	0.46	0.012	0.46	25.48
Nonanes	128.26	0.076	0.10	0.003	0.09	5.39
Decanes +	142.29	0.026	0.04	0.001	0.03	2.05
Benzene	78.11	0.106	0.08	0.002	0.12	4.58
Toluene	92.14	0.083	0.08	0.002	0.10	4.23
Ethylbenzene	106.17	0.004	0.00	0.000	0.00	0.24
Xylenes	106.17	0.023	0.02	0.001	0.03	1.35
n-Hexane	86.18	1.513	1.30	0.035	1.74	72.16
Nitrogen	28.01	0.612	0.17	0.005	0.70	9.49
Carbon Dioxide	44.01	0.460	0.20	0.005	0.53	11.20
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**50.08**	**1441.93**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**1.99**	**82.56**
TOTAL		**100.00**	**37.63**	**1.00**	**115.08**	**2082.75**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1190.26	12.58	1202.84

a Total wellsite flashing emissions are based on 1504 uncontrolled tanks and 318 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 14,830.2 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	14830.2	228.94

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60^o F.
b Assumes maximum development scenario

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Project: Greater Monument Butte Unit 1:
Date: 4/26/2013

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	746	engines
Number of Ajax Engines	404	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp)}}{\text{453.6 g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	429.1
VOC	1.3	0.31	126.8

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	336.3
VOC [c]	0.51	0.12	91.0

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2013 Emissions Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1150	140.80

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2013 Emissions Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1150 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**423.91**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C

b VOC weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2013 Emissions Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Number of wells with heater treaters	1070	wells
Number of wellpads with tanks	911	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	255.20
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	124.94

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2013 Emissions
Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	159	well pads
Vent gas from each well pad	9.28	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.02	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NO_x [a]	0.068	0.0013	0.0058	0.21	0.92

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	GMB 12/31/2013 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	8.01
Net Throughput(gal/yr):	124,779.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	Gray/Light
Shell Condition	Good
Roof Color/Shade:	Gray/Light
Roof Condition:	Good

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMB 12/31/2013 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMB 12/31/2013 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	326.4543
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	124,779.0000
Annual Turnovers:	8.0147
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,207.8279

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMB 12/31/2013 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	326.45	881.37	1,207.83

APPENDIX B-4

PROPOSED ACTION DEVELOPMENT FOR 2014

	Source ID	December 31, 2014 Emissions (tpy) [a] NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.3	0.6	8.0
	Drilling Tailpipe	3.8	0.3	4.0
	Drilling - Rigs	72.1	15.0	87.2
	Completion Tailpipe	12.3	0.9	13.2
	Completion Rigs	24.3	0.7	25.0
	Completion Venting	0.0	4.9	4.9
	Interim Reclamation Tailpipe	0.6	0.0	0.6
Production Emissions	Pump Unit Engines	641.3	179.0	820.3
	Production Heaters	233.6	112.3	345.9
	Wellsite Tanks - W&B	0.0	827.0	827.0
	Wellsite Tanks - Flashing	0.0	1,245.2	1,245.2
	Wellsite Truck Loading	0.0	249.7	249.7
	Wellsite Flares	1.2	0.0	1.2
	Wellsite Fugitives	0.0	422.4	422.4
	Wellsite Pneumatics	0.0	140.3	140.3
	Operations Vehicle	22.9	0.7	23.7
	Infrastructure	232.1	103.0	335.1
Total Emissions		**1,252**	**3,302**	**4,554**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	196	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{2000 \text{ (lb/ton)}}$$

Construction Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.65
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.075

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2014 Emissions Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	196	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	77	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.018	7.39E-03	0.038	0.0015	3.76
VOC	3.16E-03	0.020	0.00075	3.54E-03	0.018	0.00070	0.28

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	196	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	12.30
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.91

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	196	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total [c]**
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.60
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.049

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	2.5	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 0 drill rigs	0	%
Percent of Tier 2 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 0)		
Species	Drill Rig E. Factor [a]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	2.40E-02	21.82	0.00
VOC	6.42E-04	0.58	0.00

	Drill Rig Emissions (Tier 2)		
Species	Drill Rig E. Factor [b]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	1.06E-02	9.62	72.14
VOC	2.20E-03	2.00	15.03

a AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96
b Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used
c Assumes maximum development scenario

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Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	196	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

	Frac Pump Engine Emissions			Totals
Species	**E. Factor (lb/MMBtu)**	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	3.2	9.84	0.12	24.32
VOC [b]	0.090	0.28	0.0035	0.68

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96

b Emission Factor represents total Hydrocarbon Emissions

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	196	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	17.37
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.08
Propane	44.1	4.313	1.902	0.095	0.216	0.013	2.46
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.52
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	0.96
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.31
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.35
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.15
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.071
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.013
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0013
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00018
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0052
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0027
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00027
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.091
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.23
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.15
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0022
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**4.93**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.099**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**25.77**

a Assumes full development scenario

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Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	843,873	miles/year
Total Annual Pickup Mileage:	99,813	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.17	0.30	5.36E-02	12.39	22.62	22.92
VOC	1.61E-03	0.044	0.08	1.55E-03	0.36	0.65	0.73

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

KLEINFELDER

Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet):	1181.9	Btu/scf
C1-C2 Wt. Fraction:	0.794	
VOC Wt. Fraction:	0.191	
Non-HC Wt. Fraction:	0.015	
Total:	1.000	

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2014 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	16173.3	bbls oil per day-all wells
Number of Well Pads with Tanks:	817	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	179	well pads
Control Efficiency of tanks:	95	%
Average Throughput:	151,736	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.64	0.032	827.03

a Total wellsite working and breathing emissions are based on 1276 uncontrolled tanks and 358 tanks controlled at 95%.

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Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	16173	bbl/day-all wells
Number of Well Pads with Tanks:	817	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	179	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 125.50 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	48.81	376.54
Ethane	30.07	16.516	4.97	0.132	20.73	299.75
Propane	44.10	16.909	7.46	0.198	21.22	450.07
i-Butane	58.12	3.694	2.15	0.057	4.64	129.58
n-Butane	58.12	9.044	5.26	0.140	11.35	317.26
i-Pentane	72.15	3.269	2.36	0.063	4.10	142.36
n-Pentane	72.15	4.297	3.10	0.082	5.39	187.12
Cyclopentane	70.10	0.361	0.25	0.007	0.45	15.27
Hexanes	86.18	2.285	1.97	0.052	2.87	118.85
Heptanes	100.20	1.423	1.43	0.038	1.79	86.06
Octanes	114.23	0.403	0.46	0.012	0.51	27.78
Nonanes	128.26	0.076	0.10	0.003	0.10	5.88
Decanes +	142.29	0.026	0.04	0.001	0.03	2.23
Benzene	78.11	0.106	0.08	0.002	0.13	5.00
Toluene	92.14	0.083	0.08	0.002	0.10	4.62
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.26
Xylenes	106.17	0.023	0.02	0.001	0.03	1.47
n-Hexane	86.18	1.513	1.30	0.035	1.90	78.70
Nitrogen	28.01	0.612	0.17	0.005	0.77	10.35
Carbon Dioxide	44.01	0.460	0.20	0.005	0.58	12.22
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**54.61**	**1572.51**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**2.17**	**90.04**
TOTAL		**100.00**	**37.63**	**1.00**	**125.50**	**2271.37**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1227.98	17.23	1245.21

a Total wellsite flashing emissions are based on 1276 uncontrolled tanks and 358 tanks controlled at 95%.

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2014 Emissions Date: 4/26/2013

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 16,173 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	16173.3	249.68

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60^o F.
b Assumes maximum development scenario

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Project: Greater Monument Butte Unit 1:
Date: 4/26/2013

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	942	engines
Number of Ajax Engines	204	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{\text{453.6 g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	216.7
VOC	1.3	0.31	64.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	424.6
VOC [c]	0.51	0.12	115.0

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2014 Emissions Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1146	140.31

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2014 Emissions Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1146 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**422.43**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C

b VOC weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

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Project: Greater Monument Butte Unit 12/31/2014 Emissions
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	996	wells
Number of wellpads with tanks	817	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NO_x [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	233.56
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	112.31

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	179	well pads
Vent gas from each well pad	10.65	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.02	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0015	0.0067	0.27	1.19

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification	
User Identification:	GMB 12/31/2014 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank
Tank Dimensions	
Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	9.44
Net Throughput(gal/yr):	151,736.00
Is Tank Heated (y/n):	N
Paint Characteristics	
Shell Color/Shade:	Gray/Light
Shell Condition	Good
Roof Color/Shade:	Gray/Light
Roof Condition:	Good
Roof Characteristics	
Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00
Breather Vent Settings	
Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMB 12/31/2014 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMB 12/31/2014 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	396.9808
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	151,736.0000
Annual Turnovers:	9.4395
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,278.3545

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMB 12/31/2014 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	396.98	881.37	1,278.35

APPENDIX B-5

PROPOSED ACTION DEVELOPMENT FOR 2015

	Source ID	December 31, 2015 Emissions (tpy) [a] NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.1
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	86.6	18.0	104.6
	Completion Tailpipe	14.7	1.1	15.8
	Completion Rigs	29.2	0.8	30.0
	Completion Venting	0.0	5.9	5.9
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	534.8	144.9	679.7
	Production Heaters	236.5	111.0	347.5
	Wellsite Tanks - W&B	0.0	811.6	811.6
	Wellsite Tanks - Flashing	0.0	1,412.3	1,412.3
	Wellsite Truck Loading	0.0	305.8	305.8
	Wellsite Flares	1.8	0.0	1.8
	Wellsite Fugitives	0.0	380.0	380.0
	Wellsite Pneumatics	0.0	144.6	144.6
	Operations Vehicle	28.0	0.9	28.9
	Infrastructure	232.1	103.0	335.1
Total Emissions		**1,176**	**3,441**	**4,617**

a Emissions in summary tables may vary slightly due to rounding differences.

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2015 Emissions Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	235	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/pad)	(lb/mile)	(lb/hr)	(tons/yr/pad)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.78
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.090

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2015 Emissions Date: 4/26/2013

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	235	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	77	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{2000 \text{ (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.018	7.39E-03	0.038	0.0015	4.51
VOC	3.16E-03	0.020	0.00075	3.54E-03	0.018	0.00070	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	235	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	14.75
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.09

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2015 Emissions Date: 4/26/2013

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	235	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/well) * Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.72
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.059

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

KLEINFELDER

Project: Greater Monument Butte Unit 12/31/2015 Emissions
Date: 4/26/2013

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 0 drill rigs	0	%
Percent of Tier 2 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr) * Rated Horsepower (hp)* Operating Hours (hrs) * Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 0)		
Species	Drill Rig E. Factor [a]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	2.40E-02	21.82	0.00
VOC	6.42E-04	0.58	0.00

	Drill Rig Emissions (Tier 2)		
Species	Drill Rig E. Factor [b]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	1.06E-02	9.62	86.57
VOC	2.20E-03	2.00	18.04

a AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96
b Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used
c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2015 Emissions
Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	235	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

	Frac Pump Engine Emissions			Totals
Species	**E. Factor (lb/MMBtu)**	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	3.2	9.84	0.12	29.16
VOC [b]	0.090	0.28	0.0035	0.82

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2015 Emissions Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	235	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	20.83
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.70
Propane	44.1	4.313	1.902	0.095	0.216	0.013	2.94
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.62
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.16
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.37
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.42
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.18
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.085
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.015
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00022
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0063
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0033
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00033
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.109
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.28
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.18
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0026
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**5.91**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.119**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**30.90**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	1,034,425	miles/year
Total Annual Pickup Mileage:	99,813	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.17	0.30	5.36E-02	15.19	27.72	28.02
VOC	1.61E-03	0.044	0.08	1.55E-03	0.44	0.80	0.88

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2015 Emissions Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.191
Non-HC Wt. Fraction:	0.015
Total:	1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

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Project: Greater Monument Butte Unit 12/31/2015 Emissions
Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	19808.9	bbls oil per day-all wells
Number of Well Pads with Tanks:	805	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	226	well pads
Control Efficiency of tanks:	95	%
Throughput:	188,615	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.69	0.034	811.57

a Total wellsite working and breathing emissions are based on 1158 uncontrolled tanks and 452 tanks controlled at 95%.

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Project: Greater Monument Butte Unit 12/31/2015 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	19808.91	bbl/day-all wells
Number of Well Pads with Tanks:	805	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	226	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 153.72 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	59.79	461.18
Ethane	30.07	16.516	4.97	0.132	25.39	367.13
Propane	44.10	16.909	7.46	0.198	25.99	551.24
i-Butane	58.12	3.694	2.15	0.057	5.68	158.71
n-Butane	58.12	9.044	5.26	0.140	13.90	388.57
i-Pentane	72.15	3.269	2.36	0.063	5.03	174.36
n-Pentane	72.15	4.297	3.10	0.082	6.61	229.19
Cyclopentane	70.10	0.361	0.25	0.007	0.55	18.71
Hexanes	86.18	2.285	1.97	0.052	3.51	145.57
Heptanes	100.20	1.423	1.43	0.038	2.19	105.40
Octanes	114.23	0.403	0.46	0.012	0.62	34.03
Nonanes	128.26	0.076	0.10	0.003	0.12	7.21
Decanes +	142.29	0.026	0.04	0.001	0.04	2.73
Benzene	78.11	0.106	0.08	0.002	0.16	6.12
Toluene	92.14	0.083	0.08	0.002	0.13	5.65
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.31
Xylenes	106.17	0.023	0.02	0.001	0.04	1.81
n-Hexane	86.18	1.513	1.30	0.035	2.33	96.39
Nitrogen	28.01	0.612	0.17	0.005	0.94	12.67
Carbon Dioxide	44.01	0.460	0.20	0.005	0.71	14.97
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**66.89**	**1926.00**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**2.66**	**110.28**
TOTAL		**100.00**	**37.63**	**1.00**	**153.71**	**2781.95**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1385.29	27.04	1412.32

a Total wellsite flashing emissions are based on 1158 uncontrolled tanks and 452 tanks controlled at 95%.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2015 Emissions Date: 4/26/2013

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 19,808.9 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	19808.9	305.80

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60^{o}F.
b Assumes maximum development scenario

KLEINFELDER

Project: Greater Monument Butte Unit 1:
Date: 4/26/2013

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	1177	engines
Number of Ajax Engines	4	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	4.2
VOC	1.3	0.31	1.3

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	530.6
VOC [c]	0.51	0.12	143.6

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2015 Emissions Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1181	144.59

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2015 Emissions Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1181 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**380.04**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	1031	wells
Number of wellpads with tanks	805	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	236.52
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	111.01

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2015 Emissions
Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	226	well pads
Vent gas from each well pad	12.53	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0018	0.0078	0.40	1.77

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	GMB 12/31/2015 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	11.73
Net Throughput(gal/yr):	188,615.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	Gray/Light
Shell Condition	Good
Roof Color/Shade:	Gray/Light
Roof Condition:	Good

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMB 12/31/2015 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMB 12/31/2015 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	493.4659
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	188,615.0000
Annual Turnovers:	11.7338
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,374.8395

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMB 12/31/2015 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	493.47	881.37	1,374.84

APPENDIX B-6

PROPOSED ACTION DEVELOPMENT FOR 2016

KLEINFELDER
Bright People. Right Solutions.

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

	Source ID	December 31, 2016 Emissions (tpy) [a] NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	86.6	18.0	104.6
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.3	0.9	31.1
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	574.7	155.6	730.3
	Production Heaters	254.4	117.5	371.9
	Wellsite Tanks - W&B	0.0	855.4	855.4
	Wellsite Tanks - Flashing	0.0	1,631.5	1,631.5
	Wellsite Truck Loading	0.0	374.0	374.0
	Wellsite Flares	2.4	0.0	2.4
	Wellsite Fugitives	0.0	470.0	470.0
	Wellsite Pneumatics	0.0	156.1	156.1
	Operations Vehicle	34.3	1.1	35.4
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**1,243**	**3,891**	**5,134**

a Emissions in summary tables may vary slightly due to rounding differences.

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2016 Emissions Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	244	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{2000 \text{ (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/pad)	(lb/mile)	(lb/hr)	(tons/yr/pad)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

KLEINFELDER

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2016 Emissions Date: 4/26/2013

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	244	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{2000 \text{ (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00072	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

KLEINFELDER
Bright People. Right Solutions.

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	244	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.31
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	244	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total [c]**
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 0 drill rigs	0	%
Percent of Tier 2 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{2000\ \text{(lb/ton)}}$$

	Drill Rig Emissions (Tier 0)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	2.40E-02	21.82	0.00
VOC	6.42E-04	0.58	0.00

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	86.57
VOC	2.20E-03	2.00	18.04

a AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96
b Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used
c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2016 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	244	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions			Totals
	E. Factor (lb/MMBtu)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [c] (tons/yr)
NOx	3.2	9.84	0.12	30.28
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2016 Emissions Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	244	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.63
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.84
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.06
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.20
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.39
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.13**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.124**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**32.08**

a Assumes full development scenario

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	1,270,346	miles/year
Total Annual Pickup Mileage:	99,813	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.17	0.30	5.36E-02	18.65	34.05	34.35
VOC	1.61E-03	0.044	0.08	1.55E-03	0.54	0.98	1.06

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.191
Non-HC Wt. Fraction:	0.015
Total:	1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2016 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	24226.3	bbls oil per day-all wells
Number of Well Pads with Tanks:	850	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	275	well pads
Control Efficiency of tanks:	95	%
Throughput:	218,464	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.73	0.036	855.41

a Total wellsite working and breathing emissions are based on 1150 uncontrolled tanks and 550 tanks controlled at 95%.

KLEINFELDER

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	24226.28	bbl/day-all wells
Number of Well Pads with Tanks:	850	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	275	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 188.00 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	73.12	564.02
Ethane	30.07	16.516	4.97	0.132	31.05	449.00
Propane	44.10	16.909	7.46	0.198	31.79	674.17
i-Butane	58.12	3.694	2.15	0.057	6.94	194.10
n-Butane	58.12	9.044	5.26	0.140	17.00	475.22
i-Pentane	72.15	3.269	2.36	0.063	6.15	213.24
n-Pentane	72.15	4.297	3.10	0.082	8.08	280.29
Cyclopentane	70.10	0.361	0.25	0.007	0.68	22.88
Hexanes	86.18	2.285	1.97	0.052	4.30	178.03
Heptanes	100.20	1.423	1.43	0.038	2.68	128.91
Octanes	114.23	0.403	0.46	0.012	0.76	41.62
Nonanes	128.26	0.076	0.10	0.003	0.14	8.81
Decanes +	142.29	0.026	0.04	0.001	0.05	3.34
Benzene	78.11	0.106	0.08	0.002	0.20	7.49
Toluene	92.14	0.083	0.08	0.002	0.16	6.91
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.38
Xylenes	106.17	0.023	0.02	0.001	0.04	2.21
n-Hexane	86.18	1.513	1.30	0.035	2.84	117.88
Nitrogen	28.01	0.612	0.17	0.005	1.15	15.50
Carbon Dioxide	44.01	0.460	0.20	0.005	0.86	18.30
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**81.81**	**2355.50**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**3.25**	**134.88**
TOTAL		**100.00**	**37.63**	**1.00**	**187.99**	**3402.33**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1593.43	38.10	1631.53

a Total wellsite flashing emissions are based on 1150 uncontrolled tanks and 550 tanks controlled at 95%.

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 24,226.3 bbl/day-all wells

AP - 42, Chapter 5.2 L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	24226.3	374.00

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60^{o} F.
b Assumes maximum development scenario

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Project: Greater Monument Butte Unit 1:
Date: 4/26/2013

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	1275	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp)}}{\text{453.6 g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	574.7
VOC [c]	0.51	0.12	155.6

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2016 Emissions Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1275	156.10

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2016 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1275 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**469.98**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2016 Emissions Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	1125	wells
Number of wellpads with tanks	850	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	254.43
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	117.47

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2016 Emissions Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	275	well pads
Vent gas from each well pad	14.05	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NO_x [a]	0.068	0.0020	0.0088	0.55	2.42

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	GMB 12/31/2016 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	13.59
Net Throughput(gal/yr):	218,464.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	Gray/Light
Shell Condition	Good
Roof Color/Shade:	Gray/Light
Roof Condition:	Good

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMB 12/31/2016 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMB 12/31/2016 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	571.5586
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	218,464.0000
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,452.9323

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMB 12/31/2016 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	571.56	881.37	1,452.93

APPENDIX B-7

PROPOSED ACTION DEVELOPMENT FOR 2017

	Source ID	December 31, 2017 Emissions (tpy) [a] NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	86.6	18.0	104.6
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.2	0.8	31.0
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	684.3	185.2	869.5
	Production Heaters	310.7	144.2	454.9
	Wellsite Tanks - W&B	0.0	1,047.4	1,047.4
	Wellsite Tanks - Flashing	0.0	1,932.4	1,932.4
	Wellsite Truck Loading	0.0	435.1	435.1
	Wellsite Flares	2.7	0.0	2.7
	Wellsite Fugitives	0.0	504.3	504.3
	Wellsite Pneumatics	0.0	185.9	185.9
	Operations Vehicle	39.8	1.2	41.0
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**1,414**	**4,566**	**5,980**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00073	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{2000\ \text{(lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.25
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 0 drill rigs	0	%
Percent of Tier 2 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{2000 \text{ (lb/ton)}}$$

	Drill Rig Emissions (Tier 0)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	2.40E-02	21.82	0.00
VOC	6.42E-04	0.58	0.00

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	86.57
VOC	2.20E-03	2.00	18.04

a AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96
b Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used
c Assumes maximum development scenario

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Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	243	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions			Totals
	E. Factor (lb/MMBtu)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [c] (tons/yr)
NOx	3.2	9.84	0.12	30.15
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	243	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.54
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.82
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.04
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.19
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.38
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.11**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.123**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**31.95**

a Assumes full development scenario

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Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	1,469,972	miles/year
Total Annual Pickup Mileage:	127,035	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{2000 \text{ (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.21	0.38	5.36E-02	21.59	39.40	39.78
VOC	1.61E-03	0.056	0.10	1.55E-03	0.62	1.14	1.24

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.191
Non-HC Wt. Fraction:	0.015
Total:	1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

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Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	28184.3	bbls oil per day-all wells
Number of Well Pads with Tanks:	1044	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	324	well pads
Control Efficiency of tanks:	95	%
Throughput:	206,928	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.71	0.036	1047.43

a Total wellsite working and breathing emissions are based on 1440 uncontrolled tanks and 648 tanks controlled at 95%.

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Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	28184.34	bbl/day-all wells
Number of Well Pads with Tanks:	1044	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	324	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 218.71 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	85.07	656.17
Ethane	30.07	16.516	4.97	0.132	36.12	522.36
Propane	44.10	16.909	7.46	0.198	36.98	784.31
i-Butane	58.12	3.694	2.15	0.057	8.08	225.82
n-Butane	58.12	9.044	5.26	0.140	19.78	552.86
i-Pentane	72.15	3.269	2.36	0.063	7.15	248.08
n-Pentane	72.15	4.297	3.10	0.082	9.40	326.09
Cyclopentane	70.10	0.361	0.25	0.007	0.79	26.62
Hexanes	86.18	2.285	1.97	0.052	5.00	207.12
Heptanes	100.20	1.423	1.43	0.038	3.11	149.97
Octanes	114.23	0.403	0.46	0.012	0.88	48.42
Nonanes	128.26	0.076	0.10	0.003	0.17	10.25
Decanes +	142.29	0.026	0.04	0.001	0.06	3.89
Benzene	78.11	0.106	0.08	0.002	0.23	8.71
Toluene	92.14	0.083	0.08	0.002	0.18	8.04
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.45
Xylenes	106.17	0.023	0.02	0.001	0.05	2.57
n-Hexane	86.18	1.513	1.30	0.035	3.31	137.14
Nitrogen	28.01	0.612	0.17	0.005	1.34	18.03
Carbon Dioxide	44.01	0.460	0.20	0.005	1.01	21.29
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**95.17**	**2740.34**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**3.78**	**156.91**
TOTAL		**100.00**	**37.63**	**1.00**	**218.71**	**3958.19**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	1889.89	42.52	1932.41

a Total wellsite flashing emissions are based on 1440 uncontrolled tanks and 648 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 28,184.3 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	28184.3	435.10

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60^{o} F.
b Assumes maximum development scenario

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Project: Greater Monument Butte Unit 1:
Date: 4/26/2013

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	1518	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{\text{453.6 g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	684.3
VOC [c]	0.51	0.12	185.2

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2017 Emissions Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1518	185.85

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1518 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**504.26**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

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Project: Greater Monument Butte Unit 12/31/2017 Emissions
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	1368	wells
Number of wellpads with tanks	1044	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NO_x [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	310.72
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	144.18

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2017 Emissions Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	324	well pads
Vent gas from each well pad	13.46	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0019	0.0084	0.62	2.73

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	GMB 12/31/2017 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	13.59
Net Throughput(gal/yr):	206,928.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	Gray/Light
Shell Condition	Good
Roof Color/Shade:	Gray/Light
Roof Condition:	Good

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMB 12/31/2017 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F)			Liquid Bulk Temp (deg F)	Vapor Pressure (psia)			Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
		Avg.	Min.	Max.		Avg.	Min.	Max.					
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMB 12/31/2017 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	541.3774
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	206,928.0000
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,422.7511

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMB 12/31/2017 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	541.38	881.37	1,422.75

APPENDIX B-8

PROPOSED ACTION DEVELOPMENT FOR 2018

	Source ID	December 31, 2018 Emissions (tpy) [a] NO$_X$	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	46.9	2.5	49.4
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.2	0.8	31.0
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	793.8	214.9	1,008.7
	Production Heaters	367.0	170.9	537.9
	Wellsite Tanks - W&B	0.0	1,283.9	1,283.9
	Wellsite Tanks - Flashing	0.0	2,223.5	2,223.5
	Wellsite Truck Loading	0.0	494.6	494.6
	Wellsite Flares	3.1	0.0	3.1
	Wellsite Fugitives	0.0	649.1	649.1
	Wellsite Pneumatics	0.0	215.6	215.6
	Operations Vehicle	45.4	1.4	46.8
	Infrastructure	232.1	103.0	335.1
Total Emissions		**1,547**	**5,369**	**6,915**

a Emissions in summary tables may vary slightly due to rounding differences.

Construction Tailpipe Emissions

Assumptions:

Number of new wells	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total [c]**
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\text{ (g/lb)} * 2000\text{ (lb/tons)}}$$

Heavy Const.	Backhoe			Dozer			Grader			Total
Vehicles	E. Factor [a]	Emissions	Emissions	E. Factor [a]	Emissions	Emissions	E. Factor [a]	Emissions	Emissions	Emissions [b]
	(g/hp-hr)	(lb/hr)	(tons/yr)	(g/hp-hr)	(lb/hr)	(tons/yr)	(g/hp-hr)	(lb/hr)	(tons/yr)	(tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2018 Emissions Date: 4/26/2013

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00073	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.25
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{2000 \text{ (lb/ton)}}$$

Interim Rec Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total [c]**
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{2000 \text{ (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	Drill Rig E. Factor [a]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	Drill Rig E. Factor [b]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	5.73E-03	5.21	46.89
VOC	3.09E-04	0.28	2.52

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2018 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	243	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions			Totals
	E. Factor (lb/MMBtu)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [c] (tons/yr)
NOx	3.2	9.84	0.12	30.15
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

KLEINFELDER

Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	243	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.54
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.82
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.04
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.19
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.38
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.11**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.123**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**31.95**

a Assumes full development scenario

KLEINFELDER

Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	1,678,672	miles/year
Total Annual Pickup Mileage:	145,182	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.24	0.44	5.36E-02	24.65	44.99	45.43
VOC	1.61E-03	0.064	0.12	1.55E-03	0.71	1.30	1.42

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

KLEINFELDER

Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2018 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	32038.8	bbls oil per day all wells
Number of Well Pads with Tanks:	1238	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	373	well pads
Control Efficiency of tanks:	95	%
Throughput:	198,366	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.73	0.036	1283.88

a Total wellsite working and breathing emissions are based on 1730 uncontrolled tanks and 746 tanks controlled at 95%.

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Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	32038.81	bbl/day-all wells
Number of Well Pads with Tanks:	1238	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	373	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 248.62 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	96.70	745.91
Ethane	30.07	16.516	4.97	0.132	41.06	593.80
Propane	44.10	16.909	7.46	0.198	42.04	891.57
i-Butane	58.12	3.694	2.15	0.057	9.18	256.70
n-Butane	58.12	9.044	5.26	0.140	22.49	628.47
i-Pentane	72.15	3.269	2.36	0.063	8.13	282.00
n-Pentane	72.15	4.297	3.10	0.082	10.68	370.68
Cyclopentane	70.10	0.361	0.25	0.007	0.90	30.26
Hexanes	86.18	2.285	1.97	0.052	5.68	235.45
Heptanes	100.20	1.423	1.43	0.038	3.54	170.48
Octanes	114.23	0.403	0.46	0.012	1.00	55.04
Nonanes	128.26	0.076	0.10	0.003	0.19	11.65
Decanes +	142.29	0.026	0.04	0.001	0.06	4.42
Benzene	78.11	0.106	0.08	0.002	0.26	9.90
Toluene	92.14	0.083	0.08	0.002	0.21	9.14
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.51
Xylenes	106.17	0.023	0.02	0.001	0.06	2.92
n-Hexane	86.18	1.513	1.30	0.035	3.76	155.90
Nitrogen	28.01	0.612	0.17	0.005	1.52	20.50
Carbon Dioxide	44.01	0.460	0.20	0.005	1.14	24.21
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**108.19**	**3115.10**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**4.30**	**178.37**
TOTAL		**100.00**	**37.63**	**1.00**	**248.62**	**4499.52**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	2176.55	46.93	2223.47

a Total wellsite flashing emissions are based on 1730 uncontrolled tanks and 746 tanks controlled at 95%.

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Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 32,038.8 bbl/day-all wells

AP - 42, Chapter 5.2 L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	32038.8	494.60

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60^o F.
b Assumes maximum development scenario

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Project: Greater Monument Butte Unit 1:
Date: 4/26/2013

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	1761	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	793.8
VOC [c]	0.51	0.12	214.9

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

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Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
1761	215.60

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 1761 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**649.13**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

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Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	1611	wells
Number of wellpads with tanks	1238	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	367.02
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	170.90

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2018 Emissions
Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	373	well pads
Vent gas from each well pad	13.20	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NO_x [a]	0.068	0.0019	0.0083	0.70	3.08

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	GMB 12/31/2018 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	13.59
Net Throughput(gal/yr):	218,464.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	Gray/Light
Shell Condition	Good
Roof Color/Shade:	Gray/Light
Roof Condition:	Good

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMB 12/31/2018 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMB 12/31/2018 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	571.5586
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	218,463.9985
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,452.9323

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMB 12/31/2018 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	571.56	881.37	1,452.93

APPENDIX B-9

PROPOSED ACTION DEVELOPMENT FOR 2019

	Project: Greater Monument Butte Unit 12/31/2019 Emissions Date: 4/26/2013

	Source ID	December 31, 2019 Emissions (tpy) [a] NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	46.9	2.5	49.4
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.2	0.8	31.0
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	903.4	244.6	1,147.9
	Production Heaters	423.3	197.6	620.9
	Wellsite Tanks - W&B	0.0	1,446.4	1,446.4
	Wellsite Tanks - Flashing	0.0	2,606.4	2,606.4
	Wellsite Truck Loading	0.0	574.7	574.7
	Wellsite Flares	3.5	0.0	3.5
	Wellsite Fugitives	0.0	738.7	738.7
	Wellsite Pneumatics	0.0	245.4	245.4
	Operations Vehicle	52.8	1.7	54.5
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**1,720**	**6,170**	**7,890**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: Greater Monument Butte Unit 12/31/2019 Emissions
Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{2000 \text{ (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/pad)	(lb/mile)	(lb/hr)	(tons/yr/pad)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2019 Emissions Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00073	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{2000 \text{ (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.25
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2019 Emissions
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Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/well) * Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Project: Greater Monument Butte Unit 12/31/2019 Emissions
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Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	Drill Rig E. Factor [a]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	Drill Rig E. Factor [b]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	5.73E-03	5.21	46.89
VOC	3.09E-04	0.28	2.52

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	243	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions			Totals
	E. Factor (lb/MMBtu)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [c] (tons/yr)
NOx	3.2	9.84	0.12	30.15
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

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Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	243	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.54
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.82
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.04
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.19
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.38
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.009	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.11**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.123**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**31.95**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage: 1,950,889 miles/year
Total Annual Pickup Mileage: 172,404 miles/year
Hours of Pumper Operation: 10 hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.29	0.52	5.36E-02	28.65	52.28	52.81
VOC	1.61E-03	0.076	0.14	1.55E-03	0.83	1.51	1.65

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

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Project: Greater Monument Butte Unit 12/31/2019 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet):	1181.9	Btu/scf
C1-C2 Wt. Fraction:	0.794	
VOC Wt. Fraction:	0.191	
Non-HC Wt. Fraction:	0.015	
Total:	1.000	

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

Project: Greater Monument Butte Unit 12/31/2019 Emissions
Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	37229.7	bbls oil per day all wells
Number of Well Pads with Tanks:	1432	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	422	well pads
Control Efficiency of tanks:	95	%
Throughput:	199,278	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.70	0.035	1446.37

a Total wellsite working and breathing emissions are based on 2020 uncontrolled tanks and 844 tanks controlled at 95%.

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Project: Greater Monument Butte Unit 12/31/2019 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	37229.74	bbl/day-all wells
Number of Well Pads with Tanks:	1432	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	422	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 288.90 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	112.37	866.76
Ethane	30.07	16.516	4.97	0.132	47.72	690.01
Propane	44.10	16.909	7.46	0.198	48.85	1036.03
i-Butane	58.12	3.694	2.15	0.057	10.67	298.29
n-Butane	58.12	9.044	5.26	0.140	26.13	730.30
i-Pentane	72.15	3.269	2.36	0.063	9.44	327.69
n-Pentane	72.15	4.297	3.10	0.082	12.41	430.74
Cyclopentane	70.10	0.361	0.25	0.007	1.04	35.16
Hexanes	86.18	2.285	1.97	0.052	6.60	273.59
Heptanes	100.20	1.423	1.43	0.038	4.11	198.10
Octanes	114.23	0.403	0.46	0.012	1.16	63.96
Nonanes	128.26	0.076	0.10	0.003	0.22	13.54
Decanes +	142.29	0.026	0.04	0.001	0.08	5.14
Benzene	78.11	0.106	0.08	0.002	0.31	11.50
Toluene	92.14	0.083	0.08	0.002	0.24	10.63
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.59
Xylenes	106.17	0.023	0.02	0.001	0.07	3.39
n-Hexane	86.18	1.513	1.30	0.035	4.37	181.16
Nitrogen	28.01	0.612	0.17	0.005	1.77	23.82
Carbon Dioxide	44.01	0.460	0.20	0.005	1.33	28.13
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**125.72**	**3619.81**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**5.00**	**207.27**
TOTAL		**100.00**	**37.63**	**1.00**	**288.90**	**5228.53**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	2553.08	53.34	2606.42

a Total wellsite flashing emissions are based on 2020 uncontrolled tanks and 844 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 37,229.7 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	37229.7	574.74

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60^{o} F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	2004	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp)}}{\text{453.6 g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	903.4
VOC [c]	0.51	0.12	244.6

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
2004	245.35

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

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Operations Wellsite Fugitives

Number of Producting Wells 2004 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**738.70**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C

b VOC weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2019 Emissions Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	1854	wells
Number of wellpads with tanks	1432	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NO_x [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	423.31
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	197.61

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2019 Emissions
Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	422	well pads
Vent gas from each well pad	13.07	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NO_x [a]	0.068	0.0019	0.0082	0.79	3.45

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification		
User Identification:	GMB 12/31/2019 Tanks	
City:	Duchesne	
State:	Utah	
Company:	Newfield Exploration	
Type of Tank:	Vertical Fixed Roof Tank	
Description:	One (1) 400 bbl Storage Tank	
Tank Dimensions		
Shell Height (ft):		20.00
Diameter (ft):		12.00
Liquid Height (ft) :		19.00
Avg. Liquid Height (ft):		10.00
Volume (gallons):		16,074.56
Turnovers:		13.59
Net Throughput(gal/yr):		199,278.00
Is Tank Heated (y/n):	N	
Paint Characteristics		
Shell Color/Shade:	Gray/Light	
Shell Condition	Good	
Roof Color/Shade:	Gray/Light	
Roof Condition:	Good	
Roof Characteristics		
Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00
Breather Vent Settings		
Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMB 12/31/2019 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMB 12/31/2019 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	521.3631
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	199,278.0000
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,402.7367

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMB 12/31/2019 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	521.36	881.37	1,402.74

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Project: GMBU Deep Gas Wells December 31, 2019
Date: 4/26/2013

	Source ID	December 31, 2019 Deep Gas Well Emissions (tpy) [a] NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	1.8	0.2	1.9
	Drilling Tailpipe	1.4	0.1	1.5
	Drilling - Rigs	18.8	1.0	19.8
	Completion Tailpipe	1.7	0.1	1.7
	Completion Rigs	3.5	0.1	3.6
	Interim Reclamation Tailpipe	0.04	0.003	0.04
Production Emissions	Wellsite Heaters	2.3	0.1	2.4
	Wellsite Tanks	0.0	8.5	8.5
	Wellsite Truck Loading	0.0	0.9	0.9
	Wellsite Dehydrators	0.0	0.2	0.2
	Wellsite Flares	0.1	0.0	0.1
	Wellsite Fugitives	0.0	6.9	6.9
	Wellsite Pneumatics	0.0	1.5	1.5
	Operations Vehicle	0.072	0.009	0.081
	Infrastructure	7.4	9.8	17.2
	Total Emissions	**37.1**	**29.3**	**66.4**

a) Emissions in summary tables may vary slightly due to rounding differences.

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2019 Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	12	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{2000 \text{ (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/pad)	(lb/mile)	(lb/hr)	(tons/yr/pad)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.040
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.0046

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	12	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	1.74
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.15

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	600	hours per well
Number of Heavy Diesel Truck Trips	5	trips/day-well
Number of Pickup Trips	2	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.39	0.12	7.39E-03	0.015	0.0046	1.44
VOC	3.16E-03	0.016	0.0049	3.54E-03	0.0073	0.0022	0.085

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Project: GMBU Deep Gas Wells December 31, 2019
Date: 4/26/2013

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (24 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	6	trips/gas well-day
Number of Pickup Trips	2	trips/gas well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.46	0.13	7.39E-03	0.02	0.00	1.65
VOC	3.16E-03	0.02	0.006	3.54E-03	0.01	0.002	0.09

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{2000 \text{ (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.037
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0030

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2019 Date: 4/26/2013

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	1	rigs
Drilling Hours per Rig	7200	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr) * Rated Horsepower (hp)* Operating Hours (hrs) * Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	18.76
VOC	3.09E-04	0.28	1.01

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

Well Fracturing Pump

Assumptions:

Typical frac engine horsepower	660	hp
Development Rate	12	wells/year
Hours per frac job	60	hours/well
Frac engine load factor	0.62	

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/hp-hr)*hours (hour/well)*horsepower (hp)}}{\text{2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions E. Factor (lb/hp-hr)	Frac Pump Engine Emissions Emissions (lb/hr)	Frac Pump Engine Emissions Emissions (tons/yr)	Totals Emissions [c] (tons/yr)
NOx	0.024	9.82	0.29	3.54
VOC [b]	0.000705	0.29	0.0087	0.10

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

KLEINFELDER

Project: GMBU Deep Gas Wells December 31, 2019
Date: 4/26/2013

Operations Tailpipe Emissions

Assumptions:

Total Annual Tanker Truck Mileage:	1,675	miles/year
Total Annual Pickup Mileage:	9,074	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.0150	0.027	5.36E-02	0.025	0.045	0.072
VOC	1.61E-03	0.0040	0.0073	1.55E-03	0.00071	0.0013	0.0086

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2019 Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.188
Non-HC Wt. Fraction:	0.015
Total:	0.996

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Percent	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	67.412	1,010	847	910	763
Ethane	7.944	30.07	2.389	11.970	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	9.529	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	2.000	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	3.740	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	1.201	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	1.355	4,009	15.02	3,708	13.89
Hexanes	0.134	86.18	0.116	0.580	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.274	5,503	3.00	5,100	2.78
Octanes	0.0085	114.23	0.010	0.049	6,249	0.53	0.00	0.00
Nonanes	0.0008	128.26	0.001	0.005	6,996	0.06	0.00	0.00
Decanes +	0.0001	142.29	0.000	0.001	7,743	0.01	0.00	0.00
Benzene	0.0052	78.12	0.004	0.020	3,716	0.19	0.00	0.00
Toluene	0.0023	92.13	0.002	0.011	4,445	0.10	0.00	0.00
Ethylbenzene	----	106.16	----	----	5,192	----	0.00	----
Xylenes	0.00020	106.16	0.000	0.001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.353	4,756	3.89	0.00	0.00
Helium	----	4.00	----	----	0.00	----	0.00	----
Nitrogen	0.647	28.01	0.181	0.908	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.591	0.00	0.00	0.00	0.00
Oxygen	----	32.00	----	----	0.00	----	0.00	----
Hydrogen Sulfide	0.005	34.08	0.002	0.009	637	0.03	588	0.03
Total	**100.00**	**-**	**20.0**	**100.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2019 Date: 4/26/2013

Gas Well Storage Tanks

Assumptions:

Average Condensate Production Rate :

Gas well production rate	2	barrels/day
Total Gas Wells	12	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per facility
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:
Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total* Emissions (tons/yr)
Total VOC	0.71	0.000	8.51

Condensate Truck Loadout at Wellsites

Assumptions:

Condensate Well Production Rate 24.0 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Condensate Loading	0.6	5.2	66	520	4.94	24.0	0.91

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60^{o} F.
b Assumes maximum development scenario

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.004
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.0004	0.002
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.0002	0.001
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.00004	0.0002
Nonanes	128.26	0.0008	0.001	0.0051	0.00001	0.000004	0.00002
Decanes +	142.29	0.0001	0.0001	0.0007	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	----	----	----	----	----	----
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.000001	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.0003	0.001
Helium	4.00	----	----	----	----	----	----
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.0004	0.002
Oxygen	32.00	----	----	----	----	----	----
Hydrogen Sulfide	34.08	0.005	0.002	0.0085	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.001	0.0003	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.320

Number of Wells	VOC emissions (tons/year)
12	1.47

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Operations Wellsite Fugitives

Number of Producting Wells 12 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.3433
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.0847
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.0545
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.0274
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.0145
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.0480
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	0.0000
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
TOTAL VOC EMISSIONS (tons/yr)						**0.57**
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**6.87**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b VOC weight fractions from wellsite gas analysis and estimates
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

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Project: GMBU Deep Gas Wells December 31, 2019
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr
Wellsite Tank Heater Size	0	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Development size	12	producing wells
Number of wellpads with tanks	12	
Tanks per wellsite	1	new tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.044	0.19	100	0.000	0.000	100	0.000	0.000	2.32
VOC [b]	5.5	0.0024	0.011	5.5	0.000	0.000	5.5	0.000	0.000	0.13

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

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Project: GMBU Deep Gas Wells December 31, 2019
Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number controlled wellsite dehydrators	12	
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NO_x [a]	0.068	0.0018	0.0080	0.022	0.10

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: GMBU Deep Gas Wells December 31, 2019 Date: 4/26/2013

Wellsite Dehydrator Emissions

Assumptions

Average Production Rate:	0.4	MMscf/day/well
Wells Requiring Dehydrators:	12	wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95% Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions[a] (tons/year)
VOC	0.0043	0.019	0.23

a Assumes maximum development scenario

Compressor Station Scaled Emissions

Engines

Assumptions:

Engine capacity increase:	64	horsepower /well
New Development:	12	wells

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Pollutant	Emission Factor (g/hp-hr)	Emissions (lb/hr-well)	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
NOx	1.0	0.14	0.62	7.42
VOC	0.7	0.10	0.43	5.19

Dehydrator

Assumptions:

Scaled Dehydrator Emissions:	0.23	tpy VOC/MMscfd
Gas Throughput Increase:	0.4	MMscfd/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.09	1.12

Tank Emissions

Assumptions:

Scaled Tank Emissions:	0.018	tpy VOC/bbld
Gas Throughput Increase:	2.0	bbld/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.04	0.42

Fugitive Leaks

Pollutant	Emissions [a] (tons/yr)
VOC	3.03

a Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX B-10

PROPOSED ACTION DEVELOPMENT FOR 2020

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2020 Emissions Date: 4/26/2013

	Source ID	December 31, 2020 Emissions (tpy) [a] NO$_X$	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	46.9	2.5	49.4
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.2	0.8	31.0
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	1,012.9	274.2	1,287.1
	Production Heaters	479.6	224.3	703.9
	Wellsite Tanks - W&B	0.0	1,655.3	1,655.3
	Wellsite Tanks - Flashing	0.0	2,989.5	2,989.5
	Wellsite Truck Loading	0.0	654.9	654.9
	Wellsite Flares	3.9	0.0	3.9
	Wellsite Fugitives	0.0	828.3	828.3
	Wellsite Pneumatics	0.0	275.1	275.1
	Operations Vehicle	60.2	1.9	62.0
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**1,894**	**7,018**	**8,912**

a Emissions in summary tables may vary slightly due to rounding differences.

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2020 Emissions Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{2000 \text{ (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

KLEINFELDER

Project: Greater Monument Butte Unit 12/31/2020 Emissions
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2020 Emissions Date: 4/26/2013

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00073	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.25
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2020 Emissions
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Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	Drill Rig E. Factor [a]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	Drill Rig E. Factor [b]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	5.73E-03	5.21	46.89
VOC	3.09E-04	0.28	2.52

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2020 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	243	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

	Frac Pump Engine Emissions			Totals
Species	**E. Factor (lb/MMBtu)**	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	3.2	9.84	0.12	30.15
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2020 Emissions Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	243	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.54
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.82
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.04
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.19
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.38
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.11**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.123**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**31.95**

a Assumes full development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2020 Emissions Date: 4/26/2013

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	2,223,106	miles/year
Total Annual Pickup Mileage:	190,552	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{2000\ \text{(lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.32	0.58	5.36E-02	32.65	59.58	60.16
VOC	1.61E-03	0.084	0.15	1.55E-03	0.94	1.72	1.88

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

KLEINFELDER

Project: Greater Monument Butte Unit 12/31/2020 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.191
Non-HC Wt. Fraction:	0.015
Total:	1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2020 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	42420.7	bbls oil per day all wells
Number of Well Pads with Tanks:	1626	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	471	well pads
Control Efficiency of tanks:	95	%
Throughput:	199,972	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.70	0.035	1655.33

a Total wellsite working and breathing emissions are based on 2310 uncontrolled tanks and 942 tanks controlled at 95%.

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Project: Greater Monument Butte Unit 12/31/2020 Emissions
Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	42420.68	bbl/day-all wells
Number of Well Pads with Tanks:	1626	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	471	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 329.18 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	128.03	987.62
Ethane	30.07	16.516	4.97	0.132	54.37	786.21
Propane	44.10	16.909	7.46	0.198	55.66	1180.48
i-Butane	58.12	3.694	2.15	0.057	12.16	339.88
n-Butane	58.12	9.044	5.26	0.140	29.77	832.12
i-Pentane	72.15	3.269	2.36	0.063	10.76	373.38
n-Pentane	72.15	4.297	3.10	0.082	14.15	490.80
Cyclopentane	70.10	0.361	0.25	0.007	1.19	40.06
Hexanes	86.18	2.285	1.97	0.052	7.52	311.74
Heptanes	100.20	1.423	1.43	0.038	4.68	225.72
Octanes	114.23	0.403	0.46	0.012	1.33	72.88
Nonanes	128.26	0.076	0.10	0.003	0.25	15.43
Decanes +	142.29	0.026	0.04	0.001	0.09	5.86
Benzene	78.11	0.106	0.08	0.002	0.35	13.11
Toluene	92.14	0.083	0.08	0.002	0.27	12.11
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.67
Xylenes	106.17	0.023	0.02	0.001	0.08	3.87
n-Hexane	86.18	1.513	1.30	0.035	4.98	206.42
Nitrogen	28.01	0.612	0.17	0.005	2.01	27.14
Carbon Dioxide	44.01	0.460	0.20	0.005	1.51	32.05
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**143.25**	**4124.52**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**5.69**	**236.17**
TOTAL		**100.00**	**37.63**	**1.00**	**329.18**	**5957.54**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	2929.78	59.74	2989.52

a Total wellsite flashing emissions are based on 2310 uncontrolled tanks and 942 tanks controlled at 95%.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2020 Emissions Date: 4/26/2013

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 42,420.7 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	42420.7	654.88

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60^{o}F.

b Assumes maximum development scenario

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Project: Greater Monument Butte Unit 1
Date: 4/26/2013

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	2247	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	1,012.9
VOC [c]	0.51	0.12	274.2

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2020 Emissions Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
2247	275.10

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: Greater Monument Butte Unit 12/31/2020 Emissions
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 2247 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**828.28**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Project: Greater Monument Butte Unit 12/31/2020 Emissions
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	2097	wells
Number of wellpads with tanks	1626	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	479.61
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	224.32

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2020 Emissions
Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	471	well pads
Vent gas from each well pad	13.11	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0019	0.0082	0.88	3.86

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification		
User Identification:	GMB 12/31/2020 Tanks	
City:	Duchesne	
State:	Utah	
Company:	Newfield Exploration	
Type of Tank:	Vertical Fixed Roof Tank	
Description:	One (1) 400 bbl Storage Tank	
Tank Dimensions		
Shell Height (ft):		20.00
Diameter (ft):		12.00
Liquid Height (ft) :		19.00
Avg. Liquid Height (ft):		10.00
Volume (gallons):		16,074.56
Turnovers:		13.59
Net Throughput(gal/yr):		199,972.00
Is Tank Heated (y/n):	N	
Paint Characteristics		
Shell Color/Shade:	Gray/Light	
Shell Condition	Good	
Roof Color/Shade:	Gray/Light	
Roof Condition:	Good	
Roof Characteristics		
Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00
Breather Vent Settings		
Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMB 12/31/2020 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMB 12/31/2020 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	523.1787
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	199,972.0000
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,404.5524

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMB 12/31/2020 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	523.18	881.37	1,404.55

	Source ID	December 31, 2020 Deep Gas Well Emissions (tpy) [a]		
		NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	1.8	0.2	1.9
	Drilling Tailpipe	1.4	0.1	1.5
	Drilling - Rigs	18.8	1.0	19.8
	Completion Tailpipe	1.7	0.1	1.7
	Completion Rigs	3.5	0.1	3.6
	Interim Reclamation Tailpipe	0.04	0.003	0.04
Production Emissions	Wellsite Heaters	4.6	0.3	4.9
	Wellsite Tanks	0.0	17.0	17.0
	Wellsite Truck Loading	0.0	1.8	1.8
	Wellsite Dehydrators	0.0	0.5	0.5
	Wellsite Flares	0.2	0.0	0.2
	Wellsite Fugitives	0.0	13.7	13.7
	Wellsite Pneumatics	0.0	2.9	2.9
	Operations Vehicle	0.117	0.010	0.127
	Infrastructure	14.8	16.5	31.3
	Total Emissions	**47.0**	**54.2**	**101.2**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU Deep Gas Wells December 31, 2020
Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	12	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{2000 \text{ (lb/ton)}}$$

Construction Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.040
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.0046

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

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Project: GMBU Deep Gas Wells December 31, 2020
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	12	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6\text{ (g/lb)} * 2000\text{ (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	1.74
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.15

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	600	hours per well
Number of Heavy Diesel Truck Trips	5	trips/day-well
Number of Pickup Trips	2	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.39	0.12	7.39E-03	0.015	0.0046	1.44
VOC	3.16E-03	0.016	0.0049	3.54E-03	0.0073	0.0022	0.085

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (24 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	6	trips/gas well-day
Number of Pickup Trips	2	trips/gas well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.46	0.13	7.39E-03	0.02	0.00	1.65
VOC	3.16E-03	0.02	0.006	3.54E-03	0.01	0.002	0.09

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2020 Date: 4/26/2013

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.037
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0030

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2020 Date: 4/26/2013

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	1	rigs
Drilling Hours per Rig	7200	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	18.76
VOC	3.09E-04	0.28	1.01

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

Well Fracturing Pump

Assumptions:

Typical frac engine horsepower	660	hp
Development Rate	12	wells/year
Hours per frac job	60	hours/well
Frac engine load factor	0.62	

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/hp-hr)*hours (hour/well)*horsepower (hp)}}{\text{2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Totals Emissions [c] (tons/yr)
NOx	0.024	9.82	0.29	3.54
VOC [b]	0.000705	0.29	0.0087	0.10

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2020 Date: 4/26/2013

Operations Tailpipe Emissions

Assumptions:

Total Annual Tanker Truck Mileage:	3,350	miles/year
Total Annual Pickup Mileage:	9,074	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.0150	0.0274	5.36E-02	0.05	0.09	0.12
VOC	1.61E-03	0.0040	0.0073	1.55E-03	0.0014	0.003	0.010

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2020 Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet):	1181.9	Btu/scf
C1-C2 Wt. Fraction:	0.794	
VOC Wt. Fraction:	0.188	
Non-HC Wt. Fraction:	0.015	
Total:	0.996	

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Percent	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	67.412	1,010	847	910	763
Ethane	7.944	30.07	2.389	11.970	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	9.529	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	2.000	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	3.740	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	1.201	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	1.355	4,009	15.02	3,708	13.89
Hexanes	0.134	86.18	0.116	0.580	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.274	5,503	3.00	5,100	2.78
Octanes	0.0085	114.23	0.010	0.049	6,249	0.53	0.00	0.00
Nonanes	0.0008	128.26	0.001	0.005	6,996	0.06	0.00	0.00
Decanes +	0.0001	142.29	0.000	0.001	7,743	0.01	0.00	0.00
Benzene	0.0052	78.12	0.004	0.020	3,716	0.19	0.00	0.00
Toluene	0.0023	92.13	0.002	0.011	4,445	0.10	0.00	0.00
Ethylbenzene	----	106.16	----	----	5,192	----	0.00	----
Xylenes	0.00020	106.16	0.000	0.001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.353	4,756	3.89	0.00	0.00
Helium	----	4.00	----	----	0.00	----	0.00	----
Nitrogen	0.647	28.01	0.181	0.908	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.591	0.00	0.00	0.00	0.00
Oxygen	----	32.00	----	----	0.00	----	0.00	----
Hydrogen Sulfide	0.005	34.08	0.002	0.009	637	0.03	588	0.03
Total	**100.00**	**-**	**20.0**	**100.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: GMBU Deep Gas Wells December 31, 2020 Date: 4/26/2013

Gas Well Storage Tanks

Assumptions:

Average Condensate Production Rate :

Gas well production rate	2	barrels/day
Total Gas Wells	24	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per facility
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total* Emissions (tons/yr)
Total VOC	0.71	0.000	17.03

Condensate Truck Loadout at Wellsites

Assumptions:

Condensate Well Production Rate 48.0 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Condensate Loading	0.6	5.2	66	520	4.94	48.0	1.82

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60^{o} F.
b Assumes maximum development scenario

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2020 Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.004
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.0004	0.002
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.0002	0.001
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.00004	0.0002
Nonanes	128.26	0.0008	0.001	0.0051	0.00001	0.000004	0.00002
Decanes +	142.29	0.0001	0.0001	0.0007	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	----	----	----	----	----	----
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.000001	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.0003	0.001
Helium	4.00	----	----	----	----	----	----
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.0004	0.002
Oxygen	32.00	----	----	----	----	----	----
Hydrogen Sulfide	34.08	0.005	0.002	0.0085	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.001	0.0003	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.320

Number of Wells	VOC emissions (tons/year)
24	2.94

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Operations Wellsite Fugitives

Number of Producting Wells 24 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.3433
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.0847
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.0545
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.0274
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.0145
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.0480
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	0.0000
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
TOTAL VOC EMISSIONS (tons/yr)						**0.57**
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**13.74**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b VOC weight fractions from wellsite gas analysis and estimates
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2020 Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr
Wellsite Tank Heater Size	0	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Development size	24	producing wells
Number of wellpads with tanks	24	
Tanks per wellsite	1	new tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.044	0.19	100	0.000	0.000	100	0.000	0.000	4.64
VOC [b]	5.5	0.0024	0.011	5.5	0.000	0.000	5.5	0.000	0.000	0.26

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Project: GMBU Deep Gas Wells December 31, 2020
Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number controlled wellsite dehydrators	24	
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0018	0.0080	0.044	0.19

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

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Project: GMBU Deep Gas Wells December 31, 2020
Date: 4/26/2013

Wellsite Dehydrator Emissions

Assumptions

Average Production Rate:	0.4	MMscf/day/well
Wells Requiring Dehydrators:	24	wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95% Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions[a] (tons/year)
VOC	0.0043	0.019	0.45

a Assumes maximum development scenario

Compressor Station Scaled Emissions

Engines

Assumptions:

Engine capacity increase:	64	horsepower /well
New Development:	24	wells

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Pollutant	Emission Factor (g/hp-hr)	Emissions (lb/hr-well)	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
NOx	1.0	0.14	0.62	14.83
VOC	0.7	0.10	0.43	10.38

Dehydrator

Assumptions:

Scaled Dehydrator Emissions:	0.23	tpy VOC/MMscfd
Gas Throughput Increase:	0.4	MMscfd/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.09	2.24

Tank Emissions

Assumptions:

Scaled Tank Emissions:	0.018	tpy VOC/bbld
Gas Throughput Increase:	2.0	bbld/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.04	0.84

Fugitive Leaks

Pollutant	Emissions [a] (tons/yr)
VOC	3.03

a Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX B-11

PROPOSED ACTION DEVELOPMENT FOR 2021

	Source ID	December 31, 2021 Emissions (tpy) [a] NO$_X$	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	46.9	2.5	49.4
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.2	0.8	31.0
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	1,122.4	303.9	1,426.3
	Production Heaters	535.9	251.0	786.9
	Wellsite Tanks - W&B	0.0	1,864.3	1,864.3
	Wellsite Tanks - Flashing	0.0	3,372.7	3,372.7
	Wellsite Truck Loading	0.0	735.0	735.0
	Wellsite Flares	4.3	0.0	4.3
	Wellsite Fugitives	0.0	917.8	917.8
	Wellsite Pneumatics	0.0	304.9	304.9
	Operations Vehicle	67.5	2.1	69.6
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**2,067**	**7,866**	**9,934**

a Emissions in summary tables may vary slightly due to rounding differences.

Construction Tailpipe Emissions

Assumptions:

Number of new wells	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{2000 \text{ (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2021 Emissions Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2021 Emissions Date: 4/26/2013

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00073	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2021 Emissions
Date: 4/26/2013

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.25
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{2000 \text{ (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr) * Rated Horsepower (hp)* Operating Hours (hrs) * Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	46.89
VOC	3.09E-04	0.28	2.52

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2021 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	243	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions			Totals
	E. Factor (lb/MMBtu)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [c] (tons/yr)
NOx	3.2	9.84	0.12	30.15
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2021 Emissions Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	243	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.54
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.82
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.04
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.19
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.38
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.11**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.123**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**31.95**

a Assumes full development scenario

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Project: Greater Monument Butte Unit 12/31/2021 Emissions
Date: 4/26/2013

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage:	2,495,323	miles/year
Total Annual Pickup Mileage:	217,774	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.36	0.66	5.36E-02	36.64	66.87	67.53
VOC	1.61E-03	0.096	0.18	1.55E-03	1.06	1.93	2.11

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

KLEINFELDER

Project: Greater Monument Butte Unit 12/31/2021 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.191
Non-HC Wt. Fraction:	0.015
Total:	1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2021 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	47611.6	bbls oil per day all wells
Number of Well Pads with Tanks:	1820	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	520	well pads
Control Efficiency of tanks:	95	%
Throughput:	200,518	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.70	0.035	1864.33

a Total wellsite working and breathing emissions are based on 2600 uncontrolled tanks and 1040 tanks controlled at 95%.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2021 Emissions Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	47611.61	bbl/day-all wells
Number of Well Pads with Tanks:	1820	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	520	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 369.47 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	143.70	1108.47
Ethane	30.07	16.516	4.97	0.132	61.02	882.42
Propane	44.10	16.909	7.46	0.198	62.47	1324.93
i-Butane	58.12	3.694	2.15	0.057	13.65	381.47
n-Butane	58.12	9.044	5.26	0.140	33.41	933.95
i-Pentane	72.15	3.269	2.36	0.063	12.08	419.07
n-Pentane	72.15	4.297	3.10	0.082	15.88	550.86
Cyclopentane	70.10	0.361	0.25	0.007	1.33	44.96
Hexanes	86.18	2.285	1.97	0.052	8.44	349.89
Heptanes	100.20	1.423	1.43	0.038	5.26	253.34
Octanes	114.23	0.403	0.46	0.012	1.49	81.79
Nonanes	128.26	0.076	0.10	0.003	0.28	17.32
Decanes +	142.29	0.026	0.04	0.001	0.10	6.57
Benzene	78.11	0.106	0.08	0.002	0.39	14.71
Toluene	92.14	0.083	0.08	0.002	0.31	13.59
Ethylbenzene	106.17	0.004	0.00	0.000	0.01	0.75
Xylenes	106.17	0.023	0.02	0.001	0.08	4.34
n-Hexane	86.18	1.513	1.30	0.035	5.59	231.68
Nitrogen	28.01	0.612	0.17	0.005	2.26	30.46
Carbon Dioxide	44.01	0.460	0.20	0.005	1.70	35.97
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**160.78**	**4629.23**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**6.39**	**265.07**
TOTAL		**100.00**	**37.63**	**1.00**	**369.46**	**6686.55**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	3306.59	66.13	3372.73

a Total wellsite flashing emissions are based on 2600 uncontrolled tanks and 1040 tanks controlled at 95%.

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 47,611.6 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	47611.6	735.01

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60^{o} F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	2490	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp)}}{\text{453.6 g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	1,122.4
VOC [c]	0.51	0.12	303.9

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2021 Emissions Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
2490	304.85

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2021 Emissions Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 2490 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**917.85**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

Project: Greater Monument Butte Unit 12/31/2021 Emissions
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	2340	wells
Number of wellpads with tanks	1820	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NO_x [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	535.91
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	251.04

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2021 Emissions Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	520	well pads
Vent gas from each well pad	13.13	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NO_x [a]	0.068	0.0019	0.0082	0.98	4.27

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	GMB 12/31/2021 Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	13.59
Net Throughput(gal/yr):	200,518.00
Is Tank Heated (y/n):	N

Paint Characteristics

Shell Color/Shade:	Gray/Light
Shell Condition	Good
Roof Color/Shade:	Gray/Light
Roof Condition:	Good

Roof Characteristics

Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMB 12/31/2021 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMB 12/31/2021 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	524.6072
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	200,518.0000
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,405.9809

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMB 12/31/2021 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	524.61	881.37	1,405.98

	Source ID	December 31, 2021 Deep Gas Well Emissions (tpy) [a]		
		NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	1.8	0.2	1.9
	Drilling Tailpipe	1.4	0.1	1.5
	Drilling - Rigs	18.8	1.0	19.8
	Completion Tailpipe	1.7	0.1	1.7
	Completion Rigs	3.5	0.1	3.6
	Interim Reclamation Tailpipe	0.04	0.003	0.04
Production Emissions	Wellsite Heaters	7.0	0.4	7.3
	Wellsite Tanks	0.0	25.5	25.5
	Wellsite Truck Loading	0.0	2.7	2.7
	Wellsite Dehydrators	0.0	0.7	0.7
	Wellsite Flares	0.3	0.0	0.3
	Wellsite Fugitives	0.0	20.6	20.6
	Wellsite Pneumatics	0.0	4.4	4.4
	Operations Vehicle	0.162	0.011	0.173
	Infrastructure	22.2	23.2	45.5
	Total Emissions	**56.9**	**79.0**	**135.9**

a Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU Deep Gas Wells December 31, 2021
Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	12	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/pad)	(lb/mile)	(lb/hr)	(tons/yr/pad)	(tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.040
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.0046

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2021 Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	12	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr) * Horsepower (hp) * Load Factor * Hours}}{\text{453.6 (g/lb) * 2000 (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	1.74
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.15

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2021 Date: 4/26/2013

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	600	hours per well
Number of Heavy Diesel Truck Trips	5	trips/day-well
Number of Pickup Trips	2	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.39	0.12	7.39E-03	0.015	0.0046	1.44
VOC	3.16E-03	0.016	0.0049	3.54E-03	0.0073	0.0022	0.085

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: GMBU Deep Gas Wells December 31, 2021 Date: 4/26/2013

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (24 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	6	trips/gas well-day
Number of Pickup Trips	2	trips/gas well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.46	0.13	7.39E-03	0.02	0.00	1.65
VOC	3.16E-03	0.02	0.006	3.54E-03	0.01	0.002	0.09

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2021 Date: 4/26/2013

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.037
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0030

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

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Project: GMBU Deep Gas Wells December 31, 2021
Date: 4/26/2013

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	1	rigs
Drilling Hours per Rig	7200	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr) * Rated Horsepower (hp)* Operating Hours (hrs) * Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	18.76
VOC	3.09E-04	0.28	1.01

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: GMBU Deep Gas Wells December 31, 2021 Date: 4/26/2013

Well Fracturing Pump

Assumptions:

Typical frac engine horsepower	660	hp
Development Rate	12	wells/year
Hours per frac job	60	hours/well
Frac engine load factor	0.62	

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/hp-hr)*hours (hour/well)*horsepower (hp)}}{\text{2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Totals Emissions [c] (tons/yr)
NOx	0.024	9.82	0.29	3.54
VOC [b]	0.000705	0.29	0.009	0.10

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2021 Date: 4/26/2013

Operations Tailpipe Emissions

Assumptions:

Total Annual Tanker Truck Mileage:	5,026	miles/year
Total Annual Pickup Mileage:	9,074	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.0150	0.0274	5.36E-02	0.07	0.13	0.16
VOC	1.61E-03	0.0040	0.0073	1.55E-03	0.0021	0.004	0.011

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

KLEINFELDER

Project: GMBU Deep Gas Wells December 31, 2021
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.188
Non-HC Wt. Fraction:	0.015
Total:	0.996

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Percent	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	67.412	1,010	847	910	763
Ethane	7.944	30.07	2.389	11.970	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	9.529	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	2.000	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	3.740	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	1.201	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	1.355	4,009	15.02	3,708	13.89
Hexanes	0.134	86.18	0.116	0.580	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.274	5,503	3.00	5,100	2.78
Octanes	0.0085	114.23	0.010	0.049	6,249	0.53	0.00	0.00
Nonanes	0.0008	128.26	0.001	0.005	6,996	0.06	0.00	0.00
Decanes +	0.0001	142.29	0.000	0.001	7,743	0.01	0.00	0.00
Benzene	0.0052	78.12	0.004	0.020	3,716	0.19	0.00	0.00
Toluene	0.0023	92.13	0.002	0.011	4,445	0.10	0.00	0.00
Ethylbenzene	----	106.16	----	----	5,192	----	0.00	----
Xylenes	0.00020	106.16	0.000	0.001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.353	4,756	3.89	0.00	0.00
Helium	----	4.00	----	----	0.00	----	0.00	----
Nitrogen	0.647	28.01	0.181	0.908	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.591	0.00	0.00	0.00	0.00
Oxygen	----	32.00	----	----	0.00	----	0.00	----
Hydrogen Sulfide	0.005	34.08	0.002	0.009	637	0.03	588	0.03
Total	**100.00**	**-**	**20.0**	**100.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: GMBU Deep Gas Wells December 31, 2021 Date: 4/26/2013

Gas Well Storage Tanks

Assumptions:

Average Condensate Production Rate :

Gas well production rate	2	barrels/day
Total Gas Wells	36	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per facility
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total* Emissions (tons/yr)
Total VOC	0.71	0.000	25.54

KLEINFELDER Bright People. Right Solutions.	Project: GMBU Deep Gas Wells December 31, 2021 Date: 4/26/2013

Condensate Truck Loadout at Wellsites

Assumptions:

Condensate Well Production Rate 72.0 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Condensate Loading	0.6	5.2	66	520	4.94	72.0	2.72

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60^{o} F.
b Assumes maximum development scenario

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Project: GMBU Deep Gas Wells December 31, 2021
Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.004
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.0004	0.002
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.0002	0.001
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.00004	0.0002
Nonanes	128.26	0.0008	0.001	0.0051	0.00001	0.000004	0.00002
Decanes +	142.29	0.0001	0.0001	0.0007	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	----	----	----	----	----	----
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.000001	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.0003	0.001
Helium	4.00	----	----	----	----	----	----
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.0004	0.002
Oxygen	32.00	----	----	----	----	----	----
Hydrogen Sulfide	34.08	0.005	0.002	0.0085	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.001	0.0003	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.320

Number of Wells	VOC emissions (tons/year)
36	4.41

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Project: GMBU Deep Gas Wells December 31, 2021
Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 36 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.3433
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.0847
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.0545
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.0274
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.0145
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.0480
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	0.0000
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
TOTAL VOC EMISSIONS (tons/yr)						**0.57**
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**20.61**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b VOC weight fractions from wellsite gas analysis and estimates
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

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Project: GMBU Deep Gas Wells December 31, 2021
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr
Wellsite Tank Heater Size	0	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Development size	36	producing wells
Number of wellpads with tanks	36	
Tanks per wellsite	1	new tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.044	0.19	100	0.000	0.000	100	0.000	0.000	6.96
VOC [b]	5.5	0.0024	0.011	5.5	0.000	0.000	5.5	0.000	0.000	0.38

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98
b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98
c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: GMBU Deep Gas Wells December 31, 2021 Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number controlled wellsite dehydrators	36	
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0018	0.0080	0.066	0.29

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

Wellsite Dehydrator Emissions

Assumptions

Average Production Rate:	0.4	MMscf/day/well
Wells Requiring Dehydrators:	36	wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95% Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions[a] (tons/year)
VOC	0.0043	0.019	0.68

a Assumes maximum development scenario

Compressor Station Scaled Emissions

Engines

Assumptions:

Engine capacity increase: 64 horsepower /well
New Development: 36 wells

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Pollutant	Emission Factor (g/hp-hr)	Emissions (lb/hr-well)	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
NOx	1.0	0.14	0.62	22.25
VOC	0.7	0.10	0.43	15.57

Dehydrator

Assumptions:

Scaled Dehydrator Emissions: 0.23 tpy VOC/MMscfd
Gas Throughput Increase: 0.4 MMscfd/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.09	3.37

Tank Emissions

Assumptions:

Scaled Tank Emissions: 0.018 tpy VOC/bbld
Gas Throughput Increase: 2.0 bbld/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.04	1.26

Fugitive Leaks

Pollutant	Emissions [a] (tons/yr)
VOC	3.03

a Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX B-12

PROPOSED ACTION DEVELOPMENT FOR 2022

Project: Greater Monument Butte Unit 12/31/2022 Emissions
Date: 4/26/2013

	Source ID	December 31, 2022 Emissions (tpy) [a] NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	7.5	0.7	8.2
	Drilling Tailpipe	4.5	0.3	4.8
	Drilling - Rigs	46.9	2.5	49.4
	Completion Tailpipe	15.3	1.1	16.4
	Completion Rigs	30.2	0.8	31.0
	Completion Venting	0.0	6.1	6.1
	Interim Reclamation Tailpipe	0.7	0.1	0.8
Production Emissions	Pump Unit Engines	1,232.0	333.5	1,565.5
	Production Heaters	592.2	277.8	870.0
	Wellsite Tanks - W&B	0.0	2,073.3	2,073.3
	Wellsite Tanks - Flashing	0.0	3,756.0	3,756.0
	Wellsite Truck Loading	0.0	815.1	815.1
	Wellsite Flares	4.7	0.0	4.7
	Wellsite Fugitives	0.0	1,007.4	1,007.4
	Wellsite Pneumatics	0.0	334.6	334.6
	Operations Vehicle	74.9	2.3	77.2
	Infrastructure	232.1	103.0	335.1
	Total Emissions	**2,241**	**8,715**	**10,956**

a Emissions in summary tables may vary slightly due to rounding differences.

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2022 Emissions Date: 4/26/2013

Construction Tailpipe Emissions

Assumptions:

Number of new wells	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.81
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.093

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2022 Emissions Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	46	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr) * Horsepower (hp) * Load Factor * Hours}}{\text{453.6 (g/lb) * 2000 (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	6.69
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.57

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.

Project: Greater Monument Butte Unit 12/31/2022 Emissions
Date: 4/26/2013

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	74	hours per site
Number of Heavy Diesel Truck Trips	6	trips/day-well
Number of Pickup Trips	5	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.462	0.017	7.39E-03	0.038	0.0014	4.51
VOC	3.16E-03	0.020	0.00073	3.54E-03	0.018	0.00068	0.34

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	168	hours per site (7 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	9	trips/Oil well-day
Number of Pickup Trips	7	trips/Oil well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.694	0.058	7.39E-03	0.054	0.0045	15.25
VOC	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	1.13

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	243	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Interim Rec Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.74
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.061

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	3	rigs
Drilling Hours per Rig	6000	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{2000\ \text{(lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	**Drill Rig E. Factor [a]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	**Drill Rig E. Factor [b]**	**Emissions**	**Total Emissions [c]**
	(lb/hp-hr)	**(lb/hr)**	**(tons/yr)**
NOx	5.73E-03	5.21	46.89
VOC	3.09E-04	0.28	2.52

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2022 Emissions Date: 4/26/2013

Well Fracturing Pump and Generator Engines

Assumptions:

Average Gallons of Diesel used per Frac Job	566	gallons/well
Development Rate	243	
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb
Hours per frac job	25	hours/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions			Totals
	E. Factor (lb/MMBtu)	**Emissions (lb/hr)**	**Emissions (tons/yr)**	**Emissions [c] (tons/yr)**
NOx	3.2	9.84	0.12	30.15
VOC [b]	0.090	0.28	0.0035	0.85

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

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Project: Greater Monument Butte Unit 12/31/2022 Emissions
Date: 4/26/2013

Well Development Venting

Amount of Vented Gas:	5.00	Mscf (Average volume estimated)
Development Rate:	243	Wells per year
Control Rate	0	%

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.0	83.858	13.5	0.674	4.193	0.089	21.54
Ethane	30.1	7.944	2.39	0.120	0.397	0.016	3.82
Propane	44.1	4.313	1.902	0.095	0.216	0.013	3.04
i-Butane	58.1	0.687	0.399	0.020	0.034	0.0026	0.64
n-Butane	58.1	1.284	0.746	0.037	0.064	0.0049	1.19
i-Pentane	72.2	0.332	0.240	0.012	0.017	0.0016	0.38
n-Pentane	72.2	0.375	0.270	0.014	0.019	0.0018	0.43
Hexanes	86.2	0.134	0.116	0.006	0.007	0.0008	0.19
Heptanes	100	0.055	0.055	0.003	0.003	0.0004	0.088
Octanes	114	0.0085	0.010	0.0005	0.0004	0.0001	0.016
Nonanes	128	0.0008	0.001	0.0001	0.00004	0.00001	0.0016
Decanes +	142	0.0001	0.000	0.00001	0.00001	0.000001	0.00023
Benzene	78.1	0.0052	0.004	0.0002	0.0003	0.00003	0.0065
Toluene	92.1	0.0023	0.002	0.0001	0.0001	0.00001	0.0034
Ethylbenzene	106	---	---	---	---	---	---
Xylenes	106	0.0002	0.000	0.00001	0.00001	0.000001	0.00034
n-Hexane	86.2	0.082	0.070	0.004	0.004	0.0005	0.113
Helium	4.0	---	---	---	---	---	---
Nitrogen	28.0	0.647	0.181	0.009	0.032	0.001	0.29
Carbon Dioxide	44.0	0.268	0.118	0.006	0.013	0.001	0.19
Oxygen	32.0	---	---	---	---	---	---
Hydrogen Sulfide	34.1	0.005	0.002	0.0001	0.0003	0.00001	0.0027
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.36**	**0.025**	**6.11**
HAP Subtotal		**0.09**	**0.08**	**0.0039**	**0.004**	**0.0005**	**0.123**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**31.95**

a Assumes full development scenario

Operations Tailpipe Emissions

Assumptions:

Total Annual New Tanker Truck Mileage: 2,767,540 miles/year
Total Annual Pickup Mileage: 235,921 miles/year
Hours of Pumper Operation: 10 hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.39	0.71	5.36E-02	40.64	74.17	74.88
VOC	1.61E-03	0.104	0.19	1.55E-03	1.18	2.14	2.33

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

KLEINFELDER

Project: Greater Monument Butte Unit 12/31/2022 Emissions
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet):	1181.9	Btu/scf
C1-C2 Wt. Fraction:	0.794	
VOC Wt. Fraction:	0.191	
Non-HC Wt. Fraction:	0.015	
Total:	1.000	

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.0953	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.0200	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.0374	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.0120	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.0135	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.0058	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.0027	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	0.00	0.00
Nonanes	0.001	128.26	0.001	0.0001	6,996	0.06	0.00	0.00
Decanes	0.0001	142.29	0.000	0.00001	7,743	0.01	0.00	0.00
Benzene	0.005	78.12	0.004	0.0002	3,716	0.19	0.00	0.00
Toluene	0.002	92.13	0.002	0.0001	4,445	0.10	0.00	0.00
Ethylbenzene	---	106.16	---	---	5,192	---	0.00	---
Xylenes	0.00020	106.16	0.000	0.00001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	0.00	0.00
Helium	---	4.00	---	---	0.00	---	0.00	---
Nitrogen	0.647	28.01	0.181	0.0091	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.0059	0.00	0.00	0.00	0.00
Oxygen	---	32.00	---	---	0.00	---	0.00	---
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100.000**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2022 Emissions Date: 4/26/2013

Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :	52802.5	bbls oil per day all wells
Number of Well Pads with Tanks:	2014	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	569	well pads
Control Efficiency of tanks:	95	%
Throughput:	200,959	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.70	0.035	2073.34

a Total wellsite working and breathing emissions are based on 2890 uncontrolled tanks and 1138 tanks controlled at 95%.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2022 Emissions Date: 4/26/2013

Oil Storage Tank Flashing Emissions

Annual Oil Production Rate :	52802.54	bbl/day-all wells
Number of Well Pads with Tanks:	2014	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	569	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 409.75 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	159.37	1229.32
Ethane	30.07	16.516	4.97	0.132	67.67	978.63
Propane	44.10	16.909	7.46	0.198	69.28	1469.38
i-Butane	58.12	3.694	2.15	0.057	15.14	423.06
n-Butane	58.12	9.044	5.26	0.140	37.06	1035.77
i-Pentane	72.15	3.269	2.36	0.063	13.39	464.76
n-Pentane	72.15	4.297	3.10	0.082	17.61	610.91
Cyclopentane	70.10	0.361	0.25	0.007	1.48	49.87
Hexanes	86.18	2.285	1.97	0.052	9.36	388.04
Heptanes	100.20	1.423	1.43	0.038	5.83	280.96
Octanes	114.23	0.403	0.46	0.012	1.65	90.71
Nonanes	128.26	0.076	0.10	0.003	0.31	19.21
Decanes +	142.29	0.026	0.04	0.001	0.11	7.29
Benzene	78.11	0.106	0.08	0.002	0.43	16.32
Toluene	92.14	0.083	0.08	0.002	0.34	15.07
Ethylbenzene	106.17	0.004	0.00	0.000	0.02	0.84
Xylenes	106.17	0.023	0.02	0.001	0.09	4.81
n-Hexane	86.18	1.513	1.30	0.035	6.20	256.94
Nitrogen	28.01	0.612	0.17	0.005	2.51	33.78
Carbon Dioxide	44.01	0.460	0.20	0.005	1.88	39.89
Hydrogen Sulfide	34.08	0.000	0.00	0.000	0.00	0.00
VOC SUBTOTAL		**43.52**	**26.05**	**0.69**	**178.31**	**5133.94**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**7.08**	**293.97**
TOTAL		**100.00**	**37.63**	**1.00**	**409.74**	**7415.56**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	3683.49	72.52	3756.01

a Total wellsite flashing emissions are based on 2890 uncontrolled tanks and 1138 tanks controlled at 95%.

KLEINFELDER Bright People. Right Solutions.	Project: Greater Monument Butte Unit 12/31/2022 Emissions Date: 4/26/2013

Oil Truck Loadout at Wellsites

Assumptions:

Oil Well Production Rate 52,802.5 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Oil Loading	0.6	2.8	50	520	2.01	52802.5	815.15

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60^{o} F.
b Assumes maximum development scenario

Wellsite Pumping Unit Engines

Assumptions:

Number of Arrow Engines	2733	engines
Number of Ajax Engines	0	engines
Arrow Pumpjack Engine (new) Size:	65	Horsepower
Load Factor for new engines	0.38	
Ajax Pumpjack Engine (old) Size:	25	Horsepower
Load Factor for old engines	1.00	
Percent of Electric Engines	0	%

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{\text{453.6 g/lb}}$$

Wellsite Pumping Unit Engines Emissions - Ajax Engines

Pollutant	Emission Factor [a] (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx	4.4	1.06	0.0
VOC	1.3	0.31	0.0

Wellsite Pumping Unit Engines Emissions - Arrow Engines

Pollutant	Emission Factor (g/hp-hr)	Emissions (ton/yr/well)	Total Emissions [d] Proposed Action (tons/yr)
NOx [b]	1.89	0.45	1,232.0
VOC [c]	0.51	0.12	333.5

a Ajax specification sheet emission factors
b Arrow specification sheet emission factors
c Emission factor from AP-42, Table 3.2-1, July 2000. Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d Estimated at full project production.

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Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.043	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.097	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.123	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.123	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.005	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.005	0.0010	0.004
Hexanes	86.177	0.134	0.116	0.580	0.002	0.0004	0.002
Heptanes	100.204	0.055	0.055	0.274	0.001	0.0002	0.001
Octanes	114.231	0.0085	0.010	0.049	0.0001	0.00004	0.0002
Nonanes	128.258	0.0008	0.001	0.005	0.000011	0.000004	0.00002
Decanes +	142.285	0.0001	0.000	0.001	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.0001	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	---	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.001	0.000003	0.000001	0.000003
n-Hexane	86.177	0.082	0.070	0.353	0.001	0.0003	0.001
Helium	4.003	---	---	---	---	---	---
Nitrogen	28.013	0.647	0.181	0.908	0.009	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.004	0.0004	0.002
Oxygen	32	---	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.0012	0.00028	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.32

Number of Wells	VOC emissions (tons/year)
2733	334.60

(wells going to GOSP still have separator)

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

KLEINFELDER	Project: Greater Monument Butte Unit 12/31/2022 Emissions Date: 4/26/2013

Operations Wellsite Fugitives

Number of Producting Wells 2733 wells (wells going to GOSP still have separator)

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.0416
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.1173
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	0.0000
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.0155
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	0.0000
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	0.0000
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	0.0000
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	0.0000
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.0002
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.0163
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.0503
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	0.0000
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.0938
TOTAL VOC EMISSIONS (tons/yr)						**0.37**
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**1007.42**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C

b VOC weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

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Project: Greater Monument Butte Unit 12/31/2022 Emissions
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	500	Mbtu/hr
Wellsite Tank Heater Size	250	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Wells with Heater Treaters	2583	wells
Number of wellpads with tanks	2014	well pads
Tanks per wellsite	2	tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.029	0.129	100	0.029	0.129	100	0.000	0.000	592.20
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	5.5	0.000	0.000	277.75

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

Wellsite Tank Control Emissions

Assumptions

Number of wellpads with controls	569	well pads
Vent gas from each well pad	13.16	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0019	0.0082	1.07	4.68

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification		
User Identification:	GMB 12/31/2022 Tanks	
City:	Duchesne	
State:	Utah	
Company:	Newfield Exploration	
Type of Tank:	Vertical Fixed Roof Tank	
Description:	One (1) 400 bbl Storage Tank	
Tank Dimensions		
Shell Height (ft):		20.00
Diameter (ft):		12.00
Liquid Height (ft) :		19.00
Avg. Liquid Height (ft):		10.00
Volume (gallons):		16,074.56
Turnovers:		13.59
Net Throughput(gal/yr):		200,959.00
Is Tank Heated (y/n):	N	
Paint Characteristics		
Shell Color/Shade:	Gray/Light	
Shell Condition	Good	
Roof Color/Shade:	Gray/Light	
Roof Condition:	Good	
Roof Characteristics		
Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00
Breather Vent Settings		
Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMB 12/31/2022 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMB 12/31/2022 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	525.7610
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	200,959.0000
Annual Turnovers:	13.5907
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,407.1346

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMB 12/31/2022 Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	525.76	881.37	1,407.13

Project: GMBU Deep Gas Wells December 31, 2022
Date: 4/26/2013

	Source ID	December 31, 2022 Deep Gas Well Emissions (tpy) [a]		
		NO_X	VOC	NOx+VOC
Development Emissions	Construction Tailpipe	1.8	0.2	1.9
	Drilling Tailpipe	1.4	0.1	1.5
	Drilling - Rigs	18.8	1.0	19.8
	Completion Tailpipe	1.7	0.1	1.7
	Completion Rigs	3.5	0.1	3.6
	Interim Reclamation Tailpipe	0.04	0.003	0.04
Production Emissions	Wellsite Heaters	9.3	0.5	9.8
	Wellsite Tanks	0.0	34.1	34.1
	Wellsite Truck Loading	0.0	3.6	3.6
	Wellsite Dehydrators	0.0	0.9	0.9
	Wellsite Flares	0.4	0.0	0.4
	Wellsite Fugitives	0.0	27.5	27.5
	Wellsite Pneumatics	0.0	5.9	5.9
	Operations Vehicle	0.207	0.012	0.220
	Infrastructure	29.7	30.0	59.6
Total Emissions		**66.7**	**103.9**	**170.6**

a Emissions in summary tables may vary slightly due to rounding differences.

Construction Tailpipe Emissions

Assumptions:

Number of new wells	12	
Average Round Trip Distance	24.9	miles (Estimated from project area and existing road system)
Hours of Construction	36	hours per well
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	6	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/well) * Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.040
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.0046

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

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Project: GMBU Deep Gas Wells December 31, 2022
Date: 4/26/2013

Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Well Pad Construction	36	hours/well pad
Road Construction	9	hours/well pad
Pipeline Construction	23	hours/well pad
New Well Pads	12	well pads/year
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horsepower (hp)} * \text{Load Factor} * \text{Hours}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader			Total
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions [b] (tons/yr)
NOx	6.9	0.28	0.0095	8.38	1.48	0.050	8.38	2.52	0.086	1.74
VOC	0.99	0.040	0.0014	0.68	0.12	0.0041	0.68	0.20	0.0069	0.15

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: GMBU Deep Gas Wells December 31, 2022 Date: 4/26/2013

Drilling Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	600	hours per well
Number of Heavy Diesel Truck Trips	5	trips/day-well
Number of Pickup Trips	2	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.39	0.12	7.39E-03	0.015	0.0046	1.44
VOC	3.16E-03	0.016	0.0049	3.54E-03	0.0073	0.0022	0.085

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

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Project: GMBU Deep Gas Wells December 31, 2022
Date: 4/26/2013

Completion Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (24 days * 24 hours/day)
Number of Heavy Diesel Truck Trips	6	trips/gas well-day
Number of Pickup Trips	2	trips/gas well-day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(tons/yr)
NOx	7.44E-02	0.46	0.13	7.39E-03	0.02	0.00	1.65
VOC	3.16E-03	0.02	0.006	3.54E-03	0.01	0.002	0.09

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

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Project: GMBU Deep Gas Wells December 31, 2022
Date: 4/26/2013

Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	12	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	3	trips/well
Number of Pickup Trips	3	trips/well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{2000\ \text{(lb/ton)}}$$

Interim Rec Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [c]
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (tons/yr)
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.037
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0030

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2022 Date: 4/26/2013

Drill Rig Emissions

Assumptions:

Number of Active Drill Rigs	1	rigs
Drilling Hours per Rig	7200	hours/rig-year
Load Factor	0.41	
Drill Rig Engine	2,217	hp
Percent of Tier 2 drill rigs	0	%
Percent of Tier 4 drill rigs	100	%

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{\text{2000 (lb/ton)}}$$

	Drill Rig Emissions (Tier 2)		
Species	Drill Rig E. Factor [a]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	1.06E-02	9.62	0.00
VOC	2.20E-03	2.00	0.00

	Drill Rig Emissions (Tier 4)		
Species	Drill Rig E. Factor [b]	Emissions	Total Emissions [c]
	(lb/hp-hr)	(lb/hr)	(tons/yr)
NOx	5.73E-03	5.21	18.76
VOC	3.09E-04	0.28	1.01

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used

b Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: GMBU Deep Gas Wells December 31, 2022 Date: 4/26/2013

Well Fracturing Pump

Assumptions:

Typical frac engine horsepower	660	hp
Development Rate	12	wells/year
Hours per frac job	60	hours/well
Frac engine load factor	0.62	

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/hp-hr)*hours (hour/well)*horsepower (hp)}}{\text{2000 (lb/tons)}}$$

Species	Frac Pump Engine Emissions E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr)	Totals Emissions [c] (tons/yr)
NOx	0.024	9.82	0.29	3.54
VOC [b]	0.000705	0.29	0.009	0.10

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario

KLEINFELDER

Project: GMBU Deep Gas Wells December 31, 2022
Date: 4/26/2013

Operations Tailpipe Emissions

Assumptions:

Total Annual Tanker Truck Mileage:	6,701	miles/year
Total Annual Pickup Mileage:	9,074	miles/year
Hours of Pumper Operation:	10	hours per day

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/tons)}}$$

Operations	**Heavy Duty Pickups**			**Heavy Haul Trucks**			**Total**
Vehicles	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (tons/yr)
NOx	6.05E-03	0.0150	0.0274	5.36E-02	0.10	0.18	0.21
VOC	1.61E-03	0.0040	0.0073	1.55E-03	0.0028	0.005	0.012

a Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

KLEINFELDER

Project: GMBU Deep Gas Wells December 31, 2022
Date: 4/26/2013

Average Produced Gas Characteristics

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.188
Non-HC Wt. Fraction:	0.015
Total:	0.996

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Percent	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	67.412	1,010	847	910	763
Ethane	7.944	30.07	2.389	11.970	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	9.529	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	2.000	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	3.740	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	1.201	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	1.355	4,009	15.02	3,708	13.89
Hexanes	0.134	86.18	0.116	0.580	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.274	5,503	3.00	5,100	2.78
Octanes	0.0085	114.23	0.010	0.049	6,249	0.53	0.00	0.00
Nonanes	0.0008	128.26	0.001	0.005	6,996	0.06	0.00	0.00
Decanes +	0.0001	142.29	0.000	0.001	7,743	0.01	0.00	0.00
Benzene	0.0052	78.12	0.004	0.020	3,716	0.19	0.00	0.00
Toluene	0.0023	92.13	0.002	0.011	4,445	0.10	0.00	0.00
Ethylbenzene	----	106.16	----	----	5,192	----	0.00	----
Xylenes	0.00020	106.16	0.000	0.001	5,184	0.01	0.00	0.00
n-Hexane	0.082	86.18	0.070	0.353	4,756	3.89	0.00	0.00
Helium	----	4.00	----	----	0.00	----	0.00	----
Nitrogen	0.647	28.01	0.181	0.908	0.00	0.00	0.00	0.00
Carbon Dioxide	0.268	44.01	0.118	0.591	0.00	0.00	0.00	0.00
Oxygen	----	32.00	----	----	0.00	----	0.00	----
Hydrogen Sulfide	0.005	34.08	0.002	0.009	637	0.03	588	0.03
Total	**100.00**	**-**	**20.0**	**100.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2022 Date: 4/26/2013

Gas Well Storage Tanks

Assumptions:

Average Condensate Production Rate :

Gas well production rate	2	barrels/day
Total Gas Wells	48	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per facility
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total* Emissions (tons/yr)
Total VOC	0.71	0.000	34.05

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2022 Date: 4/26/2013

Condensate Truck Loadout at Wellsites

Assumptions:

Condensate Well Production Rate 96.0 bbl/day-all wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P [a]	M [a]	T	L_L lb/1000 gal	Production bpd-all wells	VOC tpy [b]
Condensate Loading	0.6	5.2	66	520	4.94	96.0	3.63

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60^{o}F.
b Assumes maximum development scenario

KLEINFELDER	Project: GMBU Deep Gas Wells December 31, 2022 Date: 4/26/2013

Operations Pneumatic Emissions

Pneumatic Device Vent Rate 1.39 scf/hr - continuous low bleed device

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.0493	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.006
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.0009	0.004
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.004
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.0004	0.002
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.0002	0.001
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.00004	0.0002
Nonanes	128.26	0.0008	0.001	0.0051	0.00001	0.000004	0.00002
Decanes +	142.29	0.0001	0.0001	0.0007	0.000001	0.000001	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.00001	0.0001
Toluene	92.13	0.0023	0.002	0.011	0.00003	0.00001	0.00003
Ethylbenzene	106.16	----	----	----	----	----	----
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.000001	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.0003	0.001
Helium	4.00	----	----	----	----	----	----
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.0007	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.0004	0.002
Oxygen	32.00	----	----	----	----	----	----
Hydrogen Sulfide	34.08	0.005	0.002	0.0085	0.0001	0.00001	0.00003
	VOC Subtotal	7.28	3.82	19.12	0.101	0.014	0.061
	HAP Subtotal	0.09	0.08	0.39	0.001	0.0003	0.0012
	Total	100.00	19.96	100.00	1.39	0.073	0.320

Number of Wells	VOC emissions (tons/year)
48	5.88

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

Operations Wellsite Fugitives

Number of Productiong Wells 48 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.3433
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.0847
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.0545
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.0274
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.0145
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	0.0000
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.0480
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	0.0000
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
TOTAL VOC EMISSIONS (tons/yr)						**0.57**
					TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]	**27.48**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b VOC weight fractions from wellsite gas analysis and estimates
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

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Project: GMBU Deep Gas Wells December 31, 2022
Date: 4/26/2013

Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr
Wellsite Tank Heater Size	0	Mbtu/hr per tank
Wellsite Line Heater Size	0	Mbtu/hr
Heater Load Factor	0.6	
Fuel Gas Heat Value	1,020	Btu/scf (Standard Heating Value)
Development size	48	producing wells
Number of wellpads with tanks	48	
Tanks per wellsite	1	new tanks

	Wellpad Separator Heater Emissions			Wellsite Tank Heater Emissions			Wellsite Line Heater Emissions			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)	Total Heater Emissions [c] (tons/yr)
NOx [a]	100	0.044	0.19	100	0.000	0.000	100	0.000	0.000	9.28
VOC [b]	5.5	0.0024	0.011	5.5	0.000	0.000	5.5	0.000	0.000	0.51

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c Assumes maximum development scenario

KLEINFELDER Bright People. Right Solutions.	Project: GMBU Deep Gas Wells December 31, 2022 Date: 4/26/2013

Wellsite Tank Control Emissions

Assumptions

Number controlled wellsite dehydrators	48	
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [b] (lb/hr)	Total Emissions [b] (tons/yr)
NOx [a]	0.068	0.0018	0.0080	0.088	0.39

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91

b Assumes maximum development scenario

Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.4 MMscf/day/well
Wells Requiring Dehydrators: 48 wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95% Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions[a] (tons/year)
VOC	0.0043	0.019	0.91

a Assumes maximum development scenario

Compressor Station Scaled Emissions

Engines

Assumptions:

Engine capacity increase:	64	horsepower /well
New Development:	48	wells

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Pollutant	Emission Factor (g/hp-hr)	Emissions (lb/hr-well)	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
NOx	1.0	0.14	0.62	29.66
VOC	0.7	0.10	0.43	20.76

Dehydrator

Assumptions:

Scaled Dehydrator Emissions:	0.23	tpy VOC/MMscfd
Gas Throughput Increase:	0.4	MMscfd/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.09	4.49

Tank Emissions

Assumptions:

Scaled Tank Emissions:	0.018	tpy VOC/bbld
Gas Throughput Increase:	2.0	bbld/well

Pollutant	Emissions (tons/yr-well)	Emissions [a] (tons/yr)
VOC	0.04	1.69

Fugitive Leaks

Pollutant	Emissions [a] (tons/yr)
VOC	3.03

a Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages:	1.25
Calculated Dry Gas Dew Point:	2.35 lbs. H2O/MMSCF
Temperature:	75.0 deg. F
Pressure:	810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX C

ALTERNATIVE B -- NO ACTION EMISSIONS

KLEINFELDER

Project: GMBU - Alternative B

Date: 7/15/2013

Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative B [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	18.2	6.5	1.6	0.0003	9.3	3.2
	Drilling	821.3	451.5	166.1	0.9	216.3	45.6
	Completion	90.6	39.5	10.3	0.05	347.0	38.1
	Interim Reclamation	1.1	1.2	0.09	0.001	24.1	2.5
	Wind Erosion	---	---	---	---	2.0	0.3
Wellsite Production Emissions	Pump Unit Engines	505.3	428.7	147.3	0.3	28.7	28.7
	Production Heaters	150.9	126.8	8.3	0.9	11.5	11.5
	Wellsite Tanks	---	---	967.2	---	---	---
	Pneumatics	---	---	96.5	---	---	---
	Fugitives	---	---	334.9	---	---	---
	Wellsite Dehydrators	---	---	79.0	---	---	---
	Wellsite Truck Loading	---	---	73.8	---	---	---
	Operations Vehicle	5.2	2.6	0.2	0.004	129.4	13.3
Water Treatment Facilities	Water Treatment Oil Tanks	---	---	21.7	---	---	---
	Water Treatment Fugitives	---	---	0.9	---	---	---
	Water Treatment Generator	18.8	37.6	13.1	0.05	1.5	1.5
Gas Processing Plant	Gas Plant Compressor Engines	11.6	23.2	8.1	0.03	0.9	0.9
	Gas Plant Heaters	0.6	0.5	0.04	0.004	0.05	0.05
	Gas Plant Flares	0.9	4.9	---	---	---	---
	Gas Plant Fugitives	---	---	0.8	---	---	---
	Gas Plant Dehydrator	---	---	11.7	---	---	---
Gas and Oil Separation Plant	GOSP Heaters	14.2	11.9	0.8	0.1	1.1	1.1
	GOSP Fugitives	---	---	11.6	---	---	---
	GOSP Generators	18.8	37.6	13.1	0.05	1.5	1.5
	GOSP Flare	0.9	4.9	---	---	---	---
	GOSP Truck Loadout and Vehicle Traffic	1.2	0.2	3.9	0.001	25.9	2.7
Compressor Station Emissions	Compressor Station Engines	154.5	309.0	108.1	0.3	5.6	5.6
	Compressor Station Tanks	---	---	2.6	---	---	---
	Compressor Station Dehydrator	---	---	23.4	---	---	---
	Compressor Station Truck Loading and Vehicle Traffic	0.1	0.03	5.6	0.0001	5.2	0.5
	Compressor Station Dehydrator Heater	1.3	1.1	0.1	0.01	0.1	0.1
	Compressor Station Flare	1.8	9.7	---	---	---	---
	Compressor Station Fugitives	---	---	6.1	---	---	---
	Total Emissions	**1,817.3**	**1,497.4**	**2,116.9**	**2.8**	**810.1**	**157.0**

a Emissions in summary tables may vary slightly due to rounding differences.

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b] Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	Total (tons/yr)
Criteria Pollutants & VOC						
NO_X	18.2	821.3	90.6	1.1	---	931.2
CO	6.5	451.5	39.5	1.2	---	498.7
VOC	1.6	166.1	10.3	0.09	---	178.1
SO_2	0.0003	0.9	0.05	0.001	---	1.0
PM_{10}	9.3	216.3	347.0	24.1	2.0	598.7
$PM_{2.5}$	3.2	45.6	38.1	2.5	0.3	89.6
Hazardous Air Pollutants						
Benzene	---	0.40	0.022	---	---	0.43
Toluene	---	0.15	0.0091	---	---	0.16
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.10	0.0040	---	---	0.10
n-Hexane	---	---	0.12	---	---	0.12
Formaldehyde	---	0.041	0.0015	---	---	0.043
Acetaldehyde	---	0.013	0.00048	---	---	0.014
Acrolein	---	0.0041	0.00015	---	---	0.0043
Naphthalene	---	0.068	0.0025	---	---	0.070
POM 2	---	0.040	0.0015	---	---	0.042
POM 5	---	0.00031	0.000011	---	---	0.00033
POM 6	---	0.0012	0.000045	---	---	0.0013
POM 7	---	0.00080	0.000029	---	---	0.00083
Greenhouses Gases						
CO_2	440.6	88,196	5,998	112	---	94,746
CH_4	0.0016	3.52	23.68	0.0037	---	27.21
N_2O	0.00057	0.71	0.047	0.0012	---	0.76
CO_2e	440.8	88,490	6,510	112	---	95,553

a Assumes maximum development scenario of 360 wells in one year
b Emissions in summary tables may vary slightly due to rounding differences.
c Total drilling emissions includes Tier II drill rig engines

KLEINFELDER	Project: GMBU - Alternative B Date: 7/15/2013

Total Project Production Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]								
	Well Pump Engines	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Dehydrators	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	505.3	150.9	---	---	---	---	---	5.2	661.4
CO	428.7	126.8	---	---	---	---	---	2.6	558.1
VOC	147.3	8.3	967.2	334.9	73.8	96.5	79.0	0.2	1,707.2
SO_2	0.3	0.9	---	---	---	---	---	0.004	1.3
PM_{10}	28.7	11.5	---	---	---	---	---	129.4	169.6
$PM_{2.5}$	28.7	11.5	---	---	---	---	---	13.3	53.4
Hazardous Air Pollutants									
Benzene	1.15	0.0032	4.04	0.92	0.34	0.10	4.60	---	11.16
Toluene	0.57	0.0051	4.81	0.96	0.43	0.054	19.46	---	26.29
Ethylbenzene	0.064	---	0.24	0.04	0.021	---	5.71	---	6.07
Xylene	0.16	---	1.62	0.31	0.15	0.0054	40.55	---	42.79
n-Hexane	0.26	2.72	44.79	11.77	3.31	1.78	---	---	64.63
Formaldehyde	32.77	0.11	---	---	---	---	---	---	32.89
Acetaldehyde	4.61	---	---	---	---	---	---	---	4.61
Acrolein	4.62	---	---	---	---	---	---	---	4.62
Methanol	1.47	---	---	---	---	---	---	---	1.47
1,1,2,2-Tetrachloroethane	0.039	---	---	---	---	---	---	---	0.04
1,1,2-Trichloroethane	0.031	---	---	---	---	---	---	---	0.03
1,3-Dichloropropene	0.026	---	---	---	---	---	---	---	0.03
1,3-Butadiene	0.49	---	---	---	---	---	---	---	0.49
2,2,4-Trimethylpentane	0.50	---	---	---	---	---	---	---	0.50
Biphenyl	0.0023	---	---	---	---	---	---	---	0.002
Carbon Tetrachloride	0.036	---	---	---	---	---	---	---	0.04
Chlorobenzene	0.026	---	---	---	---	---	---	---	0.03
Chloroform	0.028	---	---	---	---	---	---	---	0.03
Dichlorobenzene	---	0.0018	---	---	---	---	---	---	0.0018
Ethylene Dibromide	0.044	---	---	---	---	---	---	---	0.04
Methylene Chloride	0.087	---	---	---	---	---	---	---	0.09
Naphthalene	0.057	0.00092	---	---	---	---	---	---	0.06
Phenol	0.025	---	---	---	---	---	---	---	0.02
Styrene	0.033	---	---	---	---	---	---	---	0.03
Vinyl Chloride	0.015	---	---	---	---	---	---	---	0.015
PAH -POM 1	0.080	---	---	---	---	---	---	---	0.08
POM 2	0.020	0.000089	---	---	---	---	---	---	0.02
POM 3	---	0.000024	---	---	---	---	---	---	0.000024
POM 4	---	0.0000027	---	---	---	---	---	---	0.0000027
POM 5	0.000003	0.0000036	---	---	---	---	---	---	0.000007
POM 6	0.0002	0.000011	---	---	---	---	---	---	0.0002
POM 7	0.0004	0.0000027	---	---	---	---	---	---	0.0004
Greenhouse Gases									
CO_2	69,401	179,931	36.3	5.8	3.65	2.98	---	460	249,841
CH_4	1.31	3.39	338.1	667.3	29.04	340	124	0.0059	1,503
N_2O	0.13	0.34	---	---	---	---	---	0.0014	0.47
CO_2e	69,470	180,108	7,136	14,019	614	7,146	2,597	460	281,549

a Assumes maximum development scenario of 788 wells
b Emissions in summary tables may vary slightly due to rounding differences.

KLEINFELDER

Project: GMBU - Alternative B

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Total Project Infrastructure Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]									
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Generators	Central Facility Flares	Dehydrators	Compressor Engines	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC										
NO_X	16.1	---	---	---	37.6	3.6	---	166.1	1.4	224.7
CO	13.5	---	---	---	75.1	19.4	---	332.2	0.3	440.5
VOC	0.9	24.3	19.4	9.4	26.3	---	35.1	116.3	0.0	231.6
SO_2	0.1	---	---	---	0.1	---	---	0.4	0.0008	0.5
PM_{10}	1.2	---	---	---	3.0	---	---	6.5	31.1	41.8
$PM_{2.5}$	1.2	---	---	---	3.0	---	---	6.5	3.2	13.9
Hazardous Air Pollutants										
Benzene	0.00034	0.094	0.045	0.066	0.12	---	1.68	0.16	---	2.17
Toluene	0.00055	0.11	0.042	0.10	0.043	---	1.18	0.13	---	1.60
Ethylbenzene	---	0.0054	0.0019	0.0046	0.0019	---	---	0.012	---	0.025
Xylene	---	0.035	0.013	0.036	0.015	---	0.21	0.056	---	0.37
n-Hexane	0.29	1.15	0.63	0.34	---	---	1.02	0.31	---	3.74
Formaldehyde	0.012	---	---	---	1.57	---	---	15.29	---	16.87
Acetaldehyde	---	---	---	---	0.21	---	---	2.41	---	2.62
Acrolein	---	---	---	---	0.20	---	---	1.50	---	1.70
Methanol	---	---	---	---	0.23	---	---	0.77	---	1.01
1,1,2,2-Tetrachloroethane	---	---	---	---	0.0019	---	---	0.012	---	0.014
1,1,2-Trichloroethane	---	---	---	---	0.0012	---	---	0.0093	---	0.010
1,3-Dichloropropene	---	---	---	---	0.0010	---	---	0.0077	---	0.0087
1,3-Butadiene	---	---	---	---	0.051	---	---	0.091	---	0.14
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	0.070	---	0.070
Biphenyl	---	---	---	---	---	---	---	0.059	---	0.059
Carbon Tetrachloride	---	---	---	---	0.0014	---	---	0.011	---	0.012
Chlorobenzene	---	---	---	---	0.0010	---	---	0.0088	---	0.010
Chloroform	---	---	---	---	0.0011	---	---	0.0083	---	0.0094
Dichlorobenzene	0.00019	---	---	---	---	---	---	---	---	0.00019
Ethylene Dibromide	---	---	---	---	0.0016	---	---	0.013	---	0.015
Methylene Chloride	---	---	---	---	0.0032	---	---	0.0066	---	0.010
Naphthalene	0.00010	---	---	---	0.0074	---	---	0.023	---	0.031
Phenol	---	---	---	---	---	---	---	0.0067	---	0.0067
Styrene	---	---	---	---	0.00091	---	---	0.0069	---	0.0078
Tetrachloroethane	---	---	---	---	---	---	---	0.00070	---	0.00070
Vinyl Chloride	---	---	---	---	0.00055	---	---	0.0043	---	0.0049
PAH -POM 1	---	---	---	---	0.011	---	---	0.011	---	0.022
POM 2	0.000010	---	---	---	---	---	---	0.017	---	0.017
POM 3	0.0000026	---	---	---	---	---	---	---	---	0.0000026
POM 4	0.00000029	---	---	---	---	---	---	---	---	0.00000029
POM 5	0.00000039	---	---	---	---	---	---	---	---	0.00000039
POM 6	0.0000012	---	---	---	---	---	---	0.000047	---	0.000048
POM 7	0.00000029	---	---	---	---	---	---	0.00019	---	0.00019
Greenhouse Gases										
CO_2	19,199	10.7	0.4	1.2	17,924	8,906	---	71,061	115	117,217
CH_4	0.36	7.68	40.2	6.3	0.3	57	43.1	1.3	0.001	156.1
N_2O	0.036	---	---	---	0.03	0.01	---	0.1	0.0001	0.2
CO_2e	19,218	172	845	132	17,941	10,104	904	71,131	115	120,563

a Assumes maximum development scenario of 788 wells

b Emissions in summary tables may vary slightly due to rounding differences.

KLEINFELDER	Project: GMBU - Alternative B Date: 7/15/2013

Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	931.2	661.4	224.7	1,817.3
CO	498.7	558.1	440.5	1,497.4
VOC	178.1	1,707.2	231.6	2,116.9
SO_2	1.0	1.3	0.5	2.8
PM_{10}	598.7	169.6	41.8	810.1
$PM_{2.5}$	89.6	53.4	13.9	157.0
Hazardous Air Pollutants				
Benzene	0.43	11.16	2.17	13.75
Toluene	0.16	26.29	1.60	28.04
Ethylbenzene	---	6.07	0.025	6.10
Xylene	0.10	42.79	0.37	43.26
n-Hexane	0.12	64.63	3.74	68.50
Formaldehyde	0.043	32.89	16.87	49.80
Acetaldehyde	0.014	4.61	2.62	7.24
Acrolein	0.0043	4.62	1.70	6.33
Methanol	---	1.47	1.01	2.48
1,1,2,2-Tetrachloroethane	---	0.039	0.014	0.053
1,1,2-Trichloroethane	---	0.031	0.010	0.042
1,3-Dichloropropene	---	0.026	0.0087	0.035
1,3-Butadiene	---	0.49	0.14	0.63
2,2,4-Trimethylpentane	---	0.50	0.070	0.57
Biphenyl	---	0.0023	0.059	0.062
Carbon Tetrachloride	---	0.036	0.012	0.048
Chlorobenzene	---	0.026	0.010	0.036
Chloroform	---	0.028	0.0094	0.037
Dichlorobenzene	---	0.0018	0.00019	0.0020
Ethylene Dibromide	---	0.044	0.015	0.058
Methylene Chloride	---	0.087	0.010	0.10
Naphthalene	0.070	0.058	0.031	0.16
Phenol	---	0.025	0.0067	0.032
Styrene	---	0.033	0.0078	0.040
Vinyl Chloride	---	0.015	0.0049	0.020
(PAH) POM 1	---	0.080	0.022	0.10
POM 2	0.042	0.020	0.017	0.078
POM 3	---	0.000024	0.0000026	0.000027
POM 4	---	0.0000027	0.00000029	0.0000030
POM 5	0.00033	0.0000070	0.00000039	0.00033
POM 6	0.0013	0.00022	0.000048	0.0015
POM 7	0.00083	0.00040	0.00019	0.0014
Total HAPs	0.98	196.07	30.55	227.61
Greenhouse Gases				
CO_2	94,746	249,841	117,217	461,805
CH_4	27.21	1,503	156	1,686
N_2O	0.76	0.47	0.22	1.45
CO_2e	95553	281,549	120,563	497,665

a Emissions for Peak Field Development
b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative B

Date: 7/15/2013

1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	3	days per new well pad
	12	hours per day
	36	hours per new well pad
	0.3	days per expanded well pad
	3.6	hours per expanded well pad
Annual amount of new well pads	58	pads/year
Annual amount of expanded well pads	302	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]				Backhoe Emissions [a]				Total
	lbs/hr	tons/new well pad	tons/expanded pad	tons/yr [b]	lbs/hr	tons/new well pad	tons/expanded pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.035	0.0035	3.13	1.97	0.035	0.0035	3.13	6.26
PM_{15}	0.50	0.009	0.00090	0.80	0.50	0.009	0.00090	0.80	1.59
PM_{10}	0.38	0.007	0.00068	0.60	0.38	0.007	0.00068	0.60	1.20
$PM_{2.5}$	0.21	0.004	0.00037	0.33	0.21	0.004	0.00037	0.33	0.66

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	3	day grading per well pad
	12	hours/day
	36	hours per well pad
	0.3	days per expanded well pad
	3.6	hours per expanded well pad
Annual amount of new well pads	58	well pads/year
Annual amount of expanded well pads	302	well pads/year
Distance graded - New pads	1.19	miles
Distance graded - Expanded pads	0.13	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - New Pads			**Grader Construction Emissions - Expanded Pads**			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**lbs/well**	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	3.21	0.089	0.0016	0.36	0.10	0.000049	0.11
PM_{15}	1.53	0.043	0.00077	0.17	0.047	0.000024	0.052
PM_{10}	0.92	0.026	0.00046	0.10	0.028	0.000014	0.031
$PM_{2.5}$	0.10	0.0028	0.000050	0.011	0.0031	0.0000015	0.0033

a Assumes maximum development scenario

3. Road Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	4	days per mile
	12	hours per day
	0.53	miles of road per well pad
	26	hours per well pad road
Annual amount of well pads with roads	58	pads with roads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content }\%)^{1.2} * (\text{soil moisture content }\%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.025	1.46	1.97	0.025	1.46	2.92
PM_{15}	0.50	0.006	0.37	0.50	0.006	0.37	0.74
PM_{10}	0.38	0.0048	0.28	0.38	0.0048	0.28	0.56
$PM_{2.5}$	0.21	0.0026	0.15	0.21	0.003	0.15	0.31

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

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4. Road Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	26	hours per well pad roads
Road construction grading distance	0.53	miles road per well pad
Annual well pads	58	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Roads			Total Emissions
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	1.43	0.06	0.0007	0.04
PM_{15}	0.68	0.027	0.0003	0.020
PM_{10}	0.41	0.016	0.00021	0.012
$PM_{2.5}$	0.04	0.0017	0.000022	0.0013

a Assumes maximum development scenario

KLEINFELDER	Project: GMBU - Alternative B Date: 7/15/2013

5. Pipeline Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	10	days per mile
	12	hours per day
	0.53	miles of pipeline per well pad
	64	hours per well pad pipeline
Annual amount of well pads withpipeline	58	pads with pipeline/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs/hr) = 5.7 * (soil silt content %)$^{1.2}$ * (soil moisture content %)$^{-1.3}$* Control Efficiency
Emissions (PM_{15} lbs/hr) = 1.0 * (soil silt content %)$^{1.5}$ * (soil moisture content %)$^{-1.4}$ * Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment
Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.063	3.65	1.97	0.063	3.65	7.31
PM_{15}	0.50	0.016	0.93	0.50	0.016	0.93	1.86
PM_{10}	0.38	0.012	0.70	0.38	0.012	0.70	1.40
$PM_{2.5}$	0.21	0.007	0.38	0.21	0.007	0.38	0.77

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.
b Assumes maximum development scenario

6. Pipeline Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	64	hours per well pad pipeline
Pipeline construction grading distance	1.07	miles pipeline per well pad
Annual well pads	58	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Pipeline			Total Emissions
	lbs/well	lbs/hr/well pad	tons/well pad	tons/year[a]
TSP	2.86	0.045	0.0014	0.08
PM_{15}	1.37	0.021	0.0007	0.040
PM_{10}	0.82	0.013	0.00041	0.024
$PM_{2.5}$	0.09	0.0014	0.000044	0.0026

a Assumes maximum development scenario

KLEINFELDER	Project: GMBU - Alternative B Date: 7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$		Annual
November 2006	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$		Annual
	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$		Daily
	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$		Daily
	Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
	Round Trip Miles	19	
	Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)
	W = average weight in tons of vehicles traveling the road		

Paved Calculation AP-42, Chapter 13.2.1	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
January 2011	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		Annual
	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$		Daily
	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$		Daily
	Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
	Round Trip Miles	6	
	Precipitation Days (P)	45	days per year
	W = average weight in tons of vehicles traveling the road		

Construction Emissions

Hours per day	12	hour/day
Days per new pad	3	day/well pad
Number of new pads per year	58	well pads/year
Days per expanded pad	0.3	day/well pad
Number of expanded pads per year	302	well pads/year

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}-new	1.20	1.05	5.61	0.09	5.14
$PM_{2.5}$-new	0.12	0.11	0.56	0.009	0.51
PM_{10}-expand	1.20	1.05	5.61	0.009	2.67
$PM_{2.5}$-expand	0.12	0.11	0.56	0.0009	0.27

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	0.015	0.014	0.023	0.00040	0.023
$PM_{2.5}$	0.0036	0.0035	0.0056	0.00010	0.0057
PM_{10}-expand	0.015	0.014	0.023	0.000040	0.012
$PM_{2.5}$-expand	0.0036	0.0035	0.0056	0.000010	0.0030

Drilling - Oil Wells

Hours per day	24	hour/day
Days per oil well	6	day/well
Number of wells per year	265	wells /year

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	1.32	1.16	11.29	0.71	188.83
$PM_{2.5}$	0.13	0.12	1.13	0.07	18.88

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	3
Light Trucks	8,000	5
Mean Vehicle Weight	25,000	---
Total Round Trips	---	11

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	0.018	0.018	0.052	0.0036	0.95
$PM_{2.5}$	0.0045	0.0043	0.013	0.0009	0.23

Drilling - Deep Gas Wells

Hours per day	24	hour/day
Days per deep gas well	55	day/well
Number of wells per year	95	wells /year

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.45	1.27	7.90	4.57	434.12
$PM_{2.5}$	0.15	0.13	0.79	0.46	43.41

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	30,857	---
Total Round Trips	---	7

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.023	0.022	0.041	0.0261	2.48
$PM_{2.5}$	0.0055	0.0054	0.010	0.0064	0.61

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7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$ Annual
$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$ Annual
$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily
$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S) 5.1 AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles 19
Precipitation Days (P) 45 days per year (NCDC data for Ouray, UT 1955-2004)
W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily
$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles 6
Precipitation Days (P) 45 days per year
W = average weight in tons of vehicles traveling the road

Interim Reclamation

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of wells per year	360	wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		Unpaved Road Emisions		
	Daily lb/VMT	Annual lb/VMT	lb/hr-pad	ton/year-pad	Total wells ton/year
PM_{10}	1.35	1.19	4.21	0.07	23.94
$PM_{2.5}$	0.14	0.12	0.42	0.007	2.39

	Emission Factor		Paved Road Emisions		
	Daily lb/VMT	Annual lb/VMT	lb/hr-pad	ton/year-pad	Total wells ton/year
PM_{10}	0.019	0.019	0.020	0.00035	0.13
$PM_{2.5}$	0.0047	0.0046	0.0049	0.00009	0.031

Completion - Oil Well

Hours per day	24	hour/day
Days per oil well	7	day/well
Number of wells per year	265	wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	7
Haul Trucks	45,000	2
Light Trucks	8,000	7
Mean Vehicle Weight	28,813	---
Total Round Trips	---	16

	Emission Factor		Unpaved Road Emisions		
	Daily lb/VMT	Annual lb/VMT	lb/hr-well	ton/year-well	Total wells ton/year
PM_{10}	1.41	1.23	17.50	1.29	341.58
$PM_{2.5}$	0.14	0.12	1.75	0.13	34.16

	Emission Factor		Paved Road Emisions		
	Daily lb/VMT	Annual lb/VMT	lb/hr-well	ton/year-well	Total wells ton/year
PM_{10}	0.021	0.020	0.087	0.007	1.87
$PM_{2.5}$	0.0052	0.0050	0.021	0.0017	0.46

Completion - Deep Gas Well

Hours per day	24	hour/day
Days per deep gas well	24	day/well
Number of wells per year	95	wells /year

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	3
Haul Trucks	45,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	34,429	---
Total Round Trips	---	7

	Emission Factor		Unpaved Road Emisions		
	Daily lb/VMT	Annual lb/VMT	lb/hr	ton/year-pad	Total wells ton/year
PM_{10}	1.52	1.34	8.30	2.09	199.00
$PM_{2.5}$	0.15	0.13	0.83	0.21	19.90

	Emission Factor		Paved Road Emisions		
	Daily lb/VMT	Annual lb/VMT	lb/hr	ton/year-pad	Total wells ton/year
PM_{10}	0.025	0.024	0.046	0.013	1.21
$PM_{2.5}$	0.006	0.006	0.011	0.0031	0.30

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	Paved Total tons/year	Total tons/year
PM_{10}	1195.28	6.67	1201.95
$PM_{2.5}$	119.53	1.64	121.16

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

8. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	190	acres total disturbance for roads and pipelines per year
	768,737	square meters total initial disturbance for roads and pipelines
	177	acres total disturbance for well pads per year
	717,340	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed (U_{10}^{+})	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\ U_{10}^{+}$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, P = 0 for $U^* < U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	<10 µm	<2.5 µm
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	4.04	0.00
PM_{10}	2.02	0.00
$PM_{2.5}$	0.30	0.00

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9. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction - new well pad	3	days per well pad
New well pads per year	58	well pads/year
Days for construction - expanded well pad	0.3	days per well pad
Expanded well pads per year	302	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks-new pads			Heavy Duty Pickups-new pads			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.18	0.19
CO	1.98E-02	0.041	0.00074	7.26E-02	0.30	0.0054	0.34	0.36
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.021	0.022
SO_2	4.57E-05	0.000095	0.0000017	2.83E-05	0.00012	0.0000021	0.00021	0.00022
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00080	0.000014	0.010	0.010
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00074	0.000013	0.0092	0.010
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	6.67	0.12	20.61	21.52
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00086	0.000016	0.0010	0.0010
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00033	0.0000060	0.00036	0.0004
CO_2e [d]	---	13.95	0.25	---	6.79	0.12	20.75	21.66

Construction Vehicles	Heavy Haul Trucks-expanded pads			Heavy Duty Pickups-expanded pads			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.00028	7.39E-03	0.031	0.000055	0.18	0.10
CO	1.98E-02	0.041	0.000074	7.26E-02	0.30	0.00054	0.34	0.19
VOC	3.16E-03	0.0065	0.000012	3.54E-03	0.015	0.000026	0.021	0.012
SO_2	4.57E-05	0.000095	0.00000017	2.83E-05	0.00012	0.00000021	0.00021	0.00012
PM_{10}	4.22E-03	0.0087	0.000016	1.94E-04	0.00080	0.0000014	0.010	0.0052
$PM_{2.5}$	4.09E-03	0.0085	0.000015	1.79E-04	0.00074	0.0000013	0.0092	0.0050
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.025	1.61E+00	6.67	0.012	20.61	11.21
CH_4	6.56E-05	0.00014	0.00000024	2.08E-04	0.00086	0.0000016	0.0010	0.00054
N_2O	1.20E-05	0.000025	0.00000004	8.05E-05	0.00033	0.0000006	0.00036	0.00019
CO_2e [d]	---	13.95	0.025	---	6.79	0.012	20.75	11.28

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	58	new pads per year
	302	expanded pads per year
Backhoe Hours-new pad	125.5	hours per pad
Backhoe Hours-expanded pad	3.6	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer hours-new pad	125.5	hours per pad
Dozer Hours-expanded pad	3.6	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Motor Grader Hours-new pad	125.5	hours per pad
Motor Grader Hours-expanded pad	3.6	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horse Power} * \text{Hours} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe				Dozer			
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	New pad (tons/yr/pad)	Expanded (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	New pad (tons/yr/pad)	Expanded (tons/yr/pad)
Criteria Pollutants & VOC								
NOx	6.9	0.28	0.017	0.00050	8.38	1.48	0.09	0.0027
CO	3.49	0.14	0.009	0.00025	2.7	0.48	0.030	0.00086
VOC [b]	0.99	0.040	0.0025	0.000072	0.68	0.12	0.008	0.00022
PM_{10}	0.722	0.029	0.0018	0.000052	0.402	0.071	0.0045	0.00013
$PM_{2.5}$	0.722	0.029	0.0018	0.000052	0.402	0.071	0.0045	0.00013
Greenhouse Gases								
CO_2 [c]	188.2	7.59	0.48	0.014	188.2	33.31	2.09	0.060
CO_2e [e]	---	7.59	0.48	0.014	---	33.31	2.09	0.060

Heavy Const. Vehicles	Grader				Total	
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	New pad (tons/yr/pad)	Expanded (tons/yr/pad)	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC						
NOx	8.38	2.52	0.16	0.0045	4.28	17.91
CO	2.70	0.81	0.051	0.0015	1.43	5.99
VOC	0.68	0.20	0.013	0.00037	0.36	1.53
PM_{10}	0.402	0.12	0.008	0.00022	0.22	0.93
$PM_{2.5}$	0.402	0.12	0.008	0.00022	0.22	0.93
Greenhouse Gases						
CO_2	188.2	56.59	3.55	0.10	97.50	407.86
CO_2e [e]	---	56.59	3.55	0.10	97.50	407.86

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor: 73.96 kg CO_2/mmBtu
393 hp-hr = mmBtu
188.2 g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

11. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	24.9	miles
Number of oil wells drilled	265	wells
Hours of Operation	144	hours per site (oil well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (oil well)
Number of Pickup Trips	5	trips/day-well (oil well)
Number of deep gas wells drilled	95	wells
Hours of Operation	1320	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	5	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	**Heavy Haul Trucks-Oil Wells**			**Heavy Duty Pickups-Oil Wells**			**Total-Oil Wells** [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.033	7.39E-03	0.038	0.0028	0.50	9.55
CO	1.98E-02	0.12	0.0089	7.26E-02	0.38	0.027	0.50	9.52
VOC [c]	3.16E-03	0.020	0.0014	3.54E-03	0.018	0.0013	0.038	0.72
SO_2	4.57E-05	0.00028	0.000020	2.83E-05	0.00015	0.000011	0.00043	0.0082
PM_{10}	4.22E-03	0.026	0.0019	1.94E-04	0.0010	0.000072	0.027	0.52
$PM_{2.5}$	4.09E-03	0.025	0.0018	1.79E-04	0.00093	0.000067	0.026	0.50
Greenhouse Gases								
CO_2	6.73E+00	41.83	3.01	1.61E+00	8.34	0.60	50.17	957.16
CH_4	6.56E-05	0.00041	0.000029	2.08E-04	0.0011	0.000078	0.0015	0.028
N_2O	1.20E-05	0.000075	0.0000054	8.05E-05	0.00042	0.000030	0.00049	0.0094
CO_2e [d]	---	41.86	3.01	---	8.49	0.61	50.35	960.66

Drilling Vehicles	**Heavy Haul Trucks-Gas Wells**			**Heavy Duty Pickups-Gas Wells**			**Total-Gas Wells** [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.39	0.25	7.39E-03	0.015	0.010	0.40	25.12
CO	1.98E-02	0.10	0.068	7.26E-02	0.15	0.099	0.25	15.86
VOC [c]	3.16E-03	0.016	0.011	3.54E-03	0.0073	0.0048	0.024	1.49
SO_2	4.57E-05	0.00024	0.00016	2.83E-05	0.000059	0.000039	0.00030	0.019
PM_{10}	4.22E-03	0.022	0.014	1.94E-04	0.00040	0.00027	0.022	1.40
$PM_{2.5}$	4.09E-03	0.021	0.014	1.79E-04	0.00037	0.00024	0.022	1.35
Greenhouse Gases								
CO_2	6.73E+00	34.86	23.00	1.61E+00	3.34	2.20	38.19	2394.59
CH_4	6.56E-05	0.00034	0.00022	2.08E-04	0.00043	0.00028	0.00077	0.048
N_2O	1.20E-05	0.000062	0.000041	8.05E-05	0.00017	0.00011	0.00023	0.014
CO_2e [d]	---	34.88	23.02	---	3.40	2.24	38.28	2400.05

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

12. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	24.9	miles
Number of oil wells	265	wells
Hours of Operation	168	hours per site (oil well)
Number of Heavy Diesel Truck Trips	9	trips/day-well (oil well)
Number of Pickup Trips	7	trips/day-well (oil well)
Number of deep gas wells	95	wells
Hours of Operation	576	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{2000 \text{ (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks-Oil Wells			Heavy Duty Pickups-Oil Wells			Total Oil Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.69	0.058	7.39E-03	0.054	0.0045	0.75	16.63
CO	1.98E-02	0.18	0.016	7.26E-02	0.53	0.044	0.71	15.83
VOC [c]	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.055	1.23
SO_2	4.57E-05	0.00043	0.000036	2.83E-05	0.00021	0.000017	0.00063	0.014
PM_{10}	4.22E-03	0.039	0.0033	1.94E-04	0.0014	0.00012	0.041	0.91
$PM_{2.5}$	4.09E-03	0.038	0.0032	1.79E-04	0.0013	0.00011	0.039	0.88
Greenhouse Gases								
CO_2	6.73E+00	62.74	5.27	1.61E+00	11.67	0.98	74.41	1656.46
CH_4	6.56E-05	0.00061	0.000051	2.08E-04	0.0015	0.00013	0.0021	0.047
N_2O	1.20E-05	0.00011	0.0000094	8.05E-05	0.00058	0.000049	0.00070	0.015
CO_2e [d]	---	62.79	5.27	---	11.89	1.00	74.67	1662.25

Completion Vehicles	Heavy Haul Trucks-Gas Wells			Heavy Duty Pickups-Gas Wells			Total Gas Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.13	7.39E-03	0.015	0.0044	0.48	13.07
CO	1.98E-02	0.12	0.035	7.26E-02	0.15	0.043	0.27	7.48
VOC [c]	3.16E-03	0.020	0.0057	3.54E-03	0.0073	0.0021	0.027	0.74
SO_2	4.57E-05	0.00028	0.000082	2.83E-05	0.000059	0.000017	0.00034	0.0094
PM_{10}	4.22E-03	0.026	0.0076	1.94E-04	0.00040	0.00012	0.027	0.73
$PM_{2.5}$	4.09E-03	0.025	0.0073	1.79E-04	0.00037	0.00011	0.026	0.71
Greenhouse Gases								
CO_2	6.73E+00	41.83	12.05	1.61E+00	3.34	0.96	45.16	1235.64
CH_4	6.56E-05	0.00041	0.00012	2.08E-04	0.00043	0.00012	0.00084	0.023
N_2O	1.20E-05	0.000075	0.000021	8.05E-05	0.00017	0.000048	0.00024	0.0066
CO_2e [d]	---	41.86	12.06	---	3.40	0.98	45.25	1238.17

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

13. Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	360	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.169	1.10
CO	1.98E-02	0.041	0.00074	7.26E-02	0.15	0.0027	0.19	1.24
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0139	0.090
SO_2	4.57E-05	0.00009	0.0000017	2.83E-05	0.000059	0.0000011	0.00015	0.00099
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00040	0.0000072	0.0091	0.059
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00037	0.0000067	0.0088	0.057
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	3.34	0.060	17.28	111.96
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00043	0.0000078	0.00057	0.0037
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00017	0.0000030	0.00019	0.00124
CO_2e [d]	---	13.95	0.25	---	3.40	0.061	17.35	112.42

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

KLEINFELDER	Project: GMBU - Alternative B Date: 7/15/2013

14. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation-Oil well	144	hours/oil well
Development Rate-Oil well	265	oil wells/year
Drilling Hours of Operation-Gas well	1320	hours/deep gas well
Development Rate-Gas well	95	deep gas wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

$$\text{Emissions (ton/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{horsepower (hp)} * \text{Hours (hour/year)} * \text{Load factor}}{\text{2000 lb/ton}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1, 10/96

Drill Rig Emissions (Tier 2)					
Species	Drill Rig E. Factor (lb/hp-hr)	Drill Rig Emissions (lb/hr)	Oil Well Drill Rig Emissions (tons/yr-well)	Gas Well Drill Rig Emissions (tons/yr-well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	1.06E-02	9.62	0.69	6.35	786.62
CO [a]	5.73E-03	5.21	0.38	3.44	426.09
VOC [a]	2.20E-03	2.00	0.14	1.32	163.88
PM_{10} [a]	3.31E-04	0.30	0.022	0.198	24.58
$PM_{2.5}$ [a]	3.31E-04	0.30	0.022	0.198	24.58
SO_2 [b]	1.21E-05	0.011	0.00079	0.0073	0.90
Hazardous Air Pollutants					
Benzene [c]	5.43E-06	0.0049	0.00036	0.0033	0.40
Toluene [c]	1.97E-06	0.0018	0.00013	0.0012	0.15
Xylenes [c]	1.35E-06	0.0012	0.000088	0.00081	0.10
Formaldehyde [c]	5.52E-07	0.00050	0.000036	0.00033	0.041
Acetaldehyde [c]	1.76E-07	0.00016	0.000012	0.00011	0.013
Acrolein [c]	5.52E-08	0.00005	0.0000036	0.000033	0.0041
Naphthalene [d]	9.10E-07	0.00083	0.000060	0.00055	0.068
POM 2 [d,e,f]	5.39E-07	0.00049	0.000035	0.00032	0.040
POM 5 [d,e,g]	4.22E-09	0.0000038	0.00000028	0.0000025	0.00031
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000011	0.000010	0.0012
POM 7 [d,e,i]	1.07E-08	0.000010	0.00000070	0.0000064	0.00080
Greenhouse Gases					
CO_2 [j]	1.14	1037.47	74.70	684.73	84,844.05
CH_4 [j,k]	4.63E-05	0.042	0.0030	0.028	3.44
N_2O [j,k]	9.26E-06	0.0084	0.00061	0.0056	0.69
CO_2e [m]	---	1040.96	74.95	687.03	85,130

a Emission factors for Tier 2 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier 2 emission standards are not set for VOC (listed as Hydrocarbons), so the Tier 1 Standard is used
b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1
c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr
d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr
e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html
f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene
g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.
h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.
i POM 7 includes: Chrysene.
j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.
k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.
l Assumes maximum development scenario
m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

KLEINFELDER

Project: GMBU - Alternative B

Date: 7/15/2013

15. Well Fracturing Engine

Average Gallons of Diesel used per Frac Job	566	gallons/well (oil well)
Hours per frac job	25.2	hours/well (oil well)
Development Rate - Oil Wells	265	wells/year (oil wells)
Typical frac engine horsepower	660	hp (deep gas wells)
Frac engine load factor	0.62	
Hours per frac job	60	hours/well (deep gas wells)
Development Rate - Deep Gas Wells	95	wells/year (deep gas wells)
Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

Species	Frac Engine Emissions					
	E. Factor (lb/MMBtu)	E. Factor (lb/hp-hr)	Engine Emissions (lb/hr)	Oil Well Emissions (tons/yr-well)	Gas Well Emissions (tons/yr-well)	Emissions [k] (tons/yr)
Criteria Pollutants & VOC						
NOx [a]	3.2	0.024	9.84	0.12	0.30	60.94
CO [a]	0.85	5.50E-03	2.62	0.033	0.078	16.19
VOC [a]	0.09	7.05E-04	0.28	0.0035	0.0083	1.71
PM_{10} [a]	0.10	0.0007	0.31	0.0039	0.0092	1.90
$PM_{2.5}$ [a]	0.10	0.0007	0.31	0.0039	0.0092	1.90
SO_2 [a]	1.52E-03	1.21E-05	0.0047	0.000059	0.00014	0.029
Hazardous Air Pollutants						
Benzene [b]	7.76E-04	5.43E-06	0.0024	0.000030	0.000072	0.015
Toluene [b]	2.81E-04	1.97E-06	0.00086	0.000011	0.000026	0.0054
Xylenes [b]	1.93E-04	1.35E-06	0.00059	0.0000075	0.000018	0.0037
Formaldehyde [b]	7.89E-05	5.52E-07	0.00024	0.0000031	0.0000073	0.0015
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000078	0.0000010	0.0000023	0.00048
Acrolein [b]	7.88E-06	5.52E-08	0.000024	0.00000031	0.0000007	0.00015
Naphthalene [c]	1.30E-04	9.10E-07	0.00040	0.0000050	0.000012	0.0025
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00024	0.0000030	0.0000071	0.0015
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000019	0.000000023	0.00000006	0.000011
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000073	0.000000092	0.00000022	0.000045
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000047	0.000000059	0.00000014	0.000029
Greenhouse Gases						
CO_2 [i]	163.05	1.14	501.6	6.32	15.05	3105.27
CH_4 [j]	6.61E-03	4.63E-05	0.020	0.00026	0.00061	0.13
N_2O [j]	1.32E-03	9.26E-06	0.0041	0.000051	0.00012	0.03
CO_2e [l]	---	---	503.3	6.3	15.1	3,115.7

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

16. Oil Well Development Venting

Following completion, oil wells are vented prior to connnection to the gathering pipeline. Gas wells are connected to a sales line during completion.

Amount of Vented Gas:	5.0	Mscf per well (Average volume estimated)
Development Rate:	265	oil wells per year
Control Rate	0	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/well)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.04	83.858	13.453	0.674	4.193	8.86E-02	23.49
Ethane	30.07	7.944	2.389	0.120	0.397	1.57E-02	4.17
Propane	44.10	4.313	1.902	0.095	0.216	1.25E-02	3.32
i-Butane	58.12	0.687	0.399	0.020	0.034	2.63E-03	0.70
n-Butane	58.12	1.284	0.746	0.037	0.064	4.92E-03	1.30
i-Pentane	72.15	0.332	0.240	0.012	0.017	1.58E-03	0.42
n-Pentane	72.15	0.375	0.270	0.014	0.019	1.78E-03	0.47
Hexanes	86.18	0.134	0.116	0.00580	0.0067	7.63E-04	0.20
Heptanes	100.20	0.055	0.055	0.00274	0.0027	3.60E-04	0.096
Octanes	114.23	0.0085	0.010	0.00049	0.0004	6.40E-05	0.017
Nonanes	128.26	0.00080	0.001	0.00005	0.00004	6.76E-06	0.0018
Decanes +	142.29	0.00010	0.0001	0.00001	0.00001	9.37E-07	0.00025
Benzene	78.12	0.0052	0.004	0.00020	0.0003	2.68E-05	0.0071
Toluene	92.13	0.0023	0.002	0.00011	0.0001	1.40E-05	0.0037
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.00001	0.00001	1.40E-06	0.00037
n-Hexane	86.18	0.082	0.070	0.00353	0.0041	4.64E-04	0.123
Helium	4.00	----	---	---	---	---	---
Nitrogen	28.01	0.647	0.181	0.00908	0.0323	1.19E-03	0.32
Carbon Dioxide	44.01	0.268	0.118	0.00591	0.0134	7.76E-04	0.21
Oxygen	32.00	----	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.00009	0.0003	1.12E-05	0.0030
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.4**	**0.025**	**6.66**
HAP Subtotal		**0.09**	**0.08**	**0.004**	**0.004**	**0.0005**	**0.13**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**34.84**

a Assumes maximum development scenario

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17. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.191
Non-HC Wt. Fraction:	0.015
Total:	1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

18. Operations Tailpipe Emissions -Oil and Gas Wells

Assumptions:

Total Tanker Truck Mileage:	185,838	miles/year-all wells
Operation Pickup Truck Mileage:	75,511	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	2.73	4.98	6.05E-03	0.13	0.23	2.85	5.21
CO	1.02E-02	0.52	0.95	4.48E-02	0.93	1.69	1.45	2.64
VOC [c]	1.55E-03	0.08	0.14	1.61E-03	0.03	0.06	0.11	0.20
SO_2	3.07E-05	0.002	0.003	1.84E-05	0.0004	0.0007	0.0019	0.0035
PM_{10}	2.57E-03	0.13	0.24	1.31E-04	0.003	0.005	0.13	0.24
$PM_{2.5}$	2.50E-03	0.13	0.23	1.21E-04	0.003	0.005	0.13	0.24
Greenhouse Gases								
CO_2	4.520	230.1	420.0	1.050	21.7	39.6	251.9	459.6
CH_4	2.59E-05	0.0013	0.002	9.38E-05	0.002	0.004	0.003	0.006
N_2O	4.01E-06	0.0002	0.0004	2.68E-05	0.0006	0.0010	0.0008	0.0014
CO_2e [c]	---	230.2	420.2	---	21.9	40.0	252.2	460.2

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

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19. Operations Traffic Fugitive Dust Emissions - Oil and Gas Wells

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E\ (PM_{10})\ /\ VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E\ (PM_{2.5})\ /\ VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E\ (PM_{10})\ /\ VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E\ (PM_{2.5})\ /\ VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E\ (PM_{10})\ /\ VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E\ (PM_{2.5})\ /\ VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E\ (PM_{10})\ /\ VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E\ (PM_{2.5})\ /\ VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of wells not producing to GOSP	429	wells

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	20
Light Trucks	8,000	8
Mean Vehicle Weight	34,128	---
Total Round Trips	---	28

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.52	1.33	0.19	0.30	128.39
$PM_{2.5}$	0.15	0.13	0.019	0.030	12.84

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.025	0.025	0.0010	0.0019	0.80
$PM_{2.5}$	0.0061	0.0061	0.00025	0.00046	0.20

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

20. Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	3,758	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	429	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	0	well pads
Control Efficiency of tanks:	0	%
Average Throughput:	67,151	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.53	0.00	453.48
Hazardous Air Pollutants [b]			
Benzene	0.0017	0.00	1.44
Toluene	0.0016	0.00	1.33
Ethylbenzene	0.000086	0.00	0.07
Xylenes	0.00050	0.00	0.43
n-Hexane	0.026	0.00	22.70
Greenhouse Gases [b]			
CO_2	0.0041	0.00	3.52
CH_4	0.13	0.00	108.59
CO_2e	2.66	0.00	2283.82

a Total wellsite working and breathing emissions are based on 858 uncontrolled tanks and 0 tanks controlled at 0%.
b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

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21. Oil Storage Tank Flashing Emissions

Assumptions:

Oil Production Rate :	3,758	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	429	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	0	well pads
Control Efficiency of tanks:	0	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 29.16 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT PERCENT	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	16.58	11.34	87.50
Ethane	30.07	16.516	4.97	13.20	4.82	69.66
Propane	44.10	16.909	7.46	19.81	4.93	104.59
i-Butane	58.12	3.694	2.15	5.71	1.08	30.11
n-Butane	58.12	9.044	5.26	13.97	2.64	73.72
i-Pentane	72.15	3.269	2.36	6.27	0.95	33.08
n-Pentane	72.15	4.297	3.10	8.24	1.25	43.48
Cyclopentane	70.10	0.361	0.25	0.67	0.11	3.55
Hexanes	86.18	2.285	1.97	5.23	0.67	27.62
Heptanes	100.20	1.423	1.43	3.79	0.42	20.00
Octanes	114.23	0.403	0.46	1.22	0.12	6.46
Nonanes	128.26	0.076	0.10	0.26	0.022	1.37
Decanes +	142.29	0.026	0.037	0.098	0.008	0.52
Benzene	78.11	0.106	0.083	0.22	0.031	1.16
Toluene	92.14	0.083	0.076	0.20	0.024	1.07
Ethylbenzene	106.17	0.004	0.004	0.011	0.0012	0.060
Xylenes	106.17	0.023	0.024	0.065	0.0067	0.34
n-Hexane	86.18	1.513	1.30	3.46	0.44	18.29
Nitrogen	28.01	0.612	0.17	0.46	0.18	2.40
Carbon Dioxide	44.01	0.460	0.20	0.54	0.13	2.84
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**69.23**	**12.69**	**365.42**
HAP SUBTOTAL		**1.73**	**1.49**	**3.96**	**0.50**	**20.92**
TOTAL		**100.0**	**37.63**	**100.0**	**29.16**	**527.82**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	365.42	0.00	365.42
Hazardous Air Pollutants [b]			
Benzene	1.16	0.00	1.16
Toluene	1.07	0.00	1.07
Ethylbenzene	0.06	0.00	0.060
Xylenes	0.34	0.00	0.34
n-Hexane	18.29	0.00	18.29
Greenhouse Gases [b]			
CO_2	2.84	0.00	2.84
CH_4	87.50	0.00	87.50
CO_2e	1840.34	0.00	1840.3

a Total wellsite flashing emissions are based on 858 uncontrolled tanks and 0 tanks controlled at 0%.

22. Gas Well Storage Tanks Working, Breathing, and Flashing Emissions

Assumptions:

Gas well production rate	2.0	barrels/day-well
Total Gas Wells	209	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:
Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total Wellsite Emissions [a] (tons/yr)
VOC	0.71	0.00	148.26
Hazardous Air Pollutants			
Benzene	0.0069	0.00	1.44
Toluene	0.012	0.00	2.40
Ethylbenzene	0.00050	0.00	0.10
Xylenes	0.0041	0.00	0.86
n-Hexane	0.018	0.00	3.80
Greenhouse Gases			
CO_2	0.14	0.00	29.9
CH_4	0.68	0.00	142.0
CO_2e	14	0.00	3,011

a Total wellsite flashing emissions are based on 209 uncontrolled tanks and 0 tanks controlled at 0%.

23. Truck Loadout

Assumptions:

Oil Well Production Rate	8.8	bbl/day-well
Number of Oil Wells not going to a GOSP	429	wells
Gas Well Production Rate	2	bbl/day-well
Number of Gas Wells	209	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [c]
Oil Loading [a]	0.6	2.8	50	520	2.01	8.8	0.14	58.02
Condensate Loading [b]	0.6	5.2	66	520	4.94	2.0	0.076	15.82

	Oil Loading		Condensate Loading		Totals
	tpy-well [d]	tpy[c,d]	tpy-well [e]	tpy[c,e]	tpy[c]
Hazardous Air Pollutants					
Benzene	0.00043	0.18	0.00074	0.15	0.34
Toluene	0.00040	0.17	0.00123	0.26	0.43
Ethylbenzene	0.000022	0.009	0.00005	0.01	0.02
Xylenes	0.00013	0.05	0.00044	0.09	0.15
n-Hexane	0.0068	2.90	0.00194	0.41	3.31
Greenhouse Gases					
CO2	0.00105	0.45	0.01529	3.20	3.65
CH4	0.032	13.89	0.07248	15.15	29.04
CO2e	0.68	292.2	1.53731	321.30	613.50

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60^o F.
b Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60^o F.
c Assumes maximum development scenario
d Emissions estimated based on flashing analysis weight fractions
e Emissions estimated based on ratio of HAP/VOC in tank emissions

24. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.00080	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.0023	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.32

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Proposed Action	788	96.48	340.15	2.98	7,146

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

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25. Wellsite Pumping Unit Engines

Assumptions:

Older Pumpjack Engine power:	25	hp
New Pumpjack Engine power:	65	hp
Older Pumpjack Engine load factor:	1.0	
New Pumpjack Engine load factor:	0.38	
Percent of new pumpjack engines:	31	%
Number of Wells Requiring Pumping Unit Engines:	579	wells

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)} * \text{load factor}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/ton)}}$$

Pollutant	AP-42 Emission Factor (lb/MMBtu)	Older Engine Emission Factor [c] (g/hp-hr)	New Engine Emission Factor [c] (g/hp-hr)	Older Engine Emissions (lb/hr/well)	Older Engine Emissions (ton/yr-well)	New Engine Emissions (lb/hr/well)	New Engine Emissions (ton/yr-well)	Total Emissions [h] (tons/yr)
Criteria Pollutants & VOC								
NOx [b]	-	4.4	1.89	0.24	1.06	0.10	0.45	505.27
CO [b]	-	3.3	2.58	0.18	0.80	0.14	0.62	428.72
VOC [b-old, a-new]	0.12	1.3	5.12E-01	0.072	0.31	0.028	0.12	147.28
PM_{10} [a,d]	4.83E-02	2.06E-01	2.06E-01	0.011	0.050	0.011	0.049	28.68
$PM_{2.5}$ [a,d]	4.83E-02	2.06E-01	2.06E-01	0.011	0.050	0.011	0.049	28.68
SO_2 [a]	5.88E-04	2.51E-03	2.51E-03	0.00014	0.00061	0.00014	0.00060	0.35
Hazardous Air Pollutants [a]								
Benzene	1.94E-03	8.27E-03	8.27E-03	0.00046	0.0020	0.00045	0.0020	1.15
Toluene	9.63E-04	4.11E-03	4.11E-03	0.00023	0.0010	0.00022	0.0010	0.57
Ethylbenzene	1.08E-04	4.60E-04	4.60E-04	0.000025	0.00011	0.000025	0.00011	0.064
Xylenes	2.68E-04	1.14E-03	1.14E-03	0.000063	0.00028	0.000062	0.00027	0.16
Formaldehyde	5.52E-02	2.35E-01	2.35E-01	0.013	0.057	0.013	0.056	32.77
Acetaldehyde	7.76E-03	3.31E-02	3.31E-02	0.0018	0.0080	0.0018	0.0079	4.61
Acrolein	7.78E-03	3.32E-02	3.32E-02	0.0018	0.0080	0.0018	0.0079	4.62
Benzo(a)pyrene/POM5	5.68E-09	2.42E-08	2.42E-08	#########	0.00000001	#########	0.00000001	0.0000034
Biphenyl	3.95E-06	1.68E-05	1.68E-05	0.0000009	0.0000041	0.0000009	0.0000040	0.0023
Methanol	2.48E-03	1.06E-02	1.06E-02	0.00058	0.0026	0.00058	0.0025	1.47
1,1,2,2-Tetrachloroethane	6.63E-05	2.83E-04	2.83E-04	0.000016	0.000068	0.000015	0.000067	0.039
1,1,2-Trichloroethane	5.27E-05	2.25E-04	2.25E-04	0.000012	0.000054	0.000012	0.000054	0.031
1,3-Dichloropropene	4.38E-05	1.87E-04	1.87E-04	0.000010	0.000045	0.000010	0.000045	0.026
1,3-Butadiene	8.20E-04	3.50E-03	3.50E-03	0.00019	0.00084	0.00019	0.00083	0.49
2,2,4-Trimethylpentane	8.46E-04	3.61E-03	3.61E-03	0.00020	0.00087	0.00020	0.00086	0.50
Carbon Tetrachloride	6.07E-05	2.59E-04	2.59E-04	0.000014	0.000062	0.000014	0.000062	0.036
Chlorobenzene	4.44E-05	1.89E-04	1.89E-04	0.000010	0.000046	0.000010	0.000045	0.026
Chloroform	4.71E-05	2.01E-04	2.01E-04	0.000011	0.000048	0.000011	0.000048	0.028
Chrysene/POM7	6.72E-07	2.87E-06	2.87E-06	0.0000002	0.0000007	0.0000002	0.0000007	0.00040
Ethylene Dibromide	7.34E-05	3.13E-04	3.13E-04	0.000017	0.000076	0.000017	0.000075	0.044
Methylene Chloride	1.47E-04	6.27E-04	6.27E-04	0.000035	0.00015	0.000034	0.00015	0.087
n-Hexane	4.45E-04	1.90E-03	1.90E-03	0.00010	0.00046	0.00010	0.00045	0.26
Naphthalene	9.63E-05	4.11E-04	4.11E-04	0.000023	0.000099	0.000022	0.000098	0.057
Phenol	4.21E-05	1.80E-04	1.80E-04	0.000010	0.000043	0.000010	0.000043	0.025
Styrene	5.48E-05	2.34E-04	2.34E-04	0.000013	0.000056	0.000013	0.000056	0.033
Vinyl Chloride	2.47E-05	1.05E-04	1.05E-04	0.000006	0.000025	0.0000057	0.000025	0.015
PAH	1.34E-04	5.71E-04	5.71E-04	0.000031	0.00014	0.000031	0.00014	0.080
POM -2 [e]	3.28E-05	1.40E-04	1.40E-04	0.0000077	0.000034	0.0000076	0.000033	0.020
POM-6 [f]	3.50E-07	1.49E-06	1.49E-06	0.0000001	0.0000004	0.0000001	0.0000004	0.00021
Greenhouse Gases								
CO_2 [g]	117	498	498	27.47	120.31	27.14	118.9	69,401
CH_4 [g]	0.002	0.01	0.01	0.001	0.0023	0.001	0.0022	1.31
N_2O [g]	0.0002	0.0009	0.0009	0.0001	0.00023	0.0001	0.00022	0.13
CO_2e [i]	----	----	----	27.50	120.4307	27.17	118.98	69,470

a AP-42 Table 3.2-1 Uncontrolled Emission Factors for 2-Stroke Lean-Burn Engines, 7/00

b Emission factors (g/hp-hr) from manufacturer specifications

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, benzo(a)fluoranthene, benzo(e)pyrene, fluorene, phenanthrene, perylene, and pyrene.

f POM 6 includes: Benz(a)anthracene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

h Estimated at full project production.

i Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Project: GMBU - Alternative B

Date: 7/15/2013

26. Production Heater Emissions

Assumptions

Oil Wellsite Separator Heater Size	500	Mbtu/hr
Oil Wellsite Tank Heater Size	250	Mbtu/hr per tank
Gas Wellsite Separator/Dehydrator Heater Size	750	Mbtu/hr
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Oil wells with heater treaters and tanks	429	wells
Gas wells with separators/dehydrators	209	wells
Load Factor	0.6	load rate

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf) * Fuel Consumption (MMscf/yr) * Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton) * 1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

		Oil Well Separator Heater		Oil Well Tank Heaters		Gas Well Dehydrator Heater		Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Well Emissions (tons/yr-well)	Well Emissions (lb/hr/well)	Well Emissions (tons/yr-well)	Well Emissions (lb/hr/well)	Well Emissions (tons/yr-well)	Total Emissions (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC									
NOx [a]	100	0.029	0.13	0.029	0.13	0.044	0.19	34.46	150.92
CO [a]	84	0.025	0.11	0.025	0.11	0.037	0.16	28.94	126.77
VOC [b]	5.5	0.0016	0.0071	0.0016	0.0071	0.0024	0.0106	1.90	8.30
SO_2 [b]	0.6	0.00018	0.00077	0.00018	0.00077	0.00026	0.00116	0.21	0.91
PM_{10} [b]	7.6	0.0022	0.0098	0.0022	0.0098	0.0034	0.0147	2.62	11.47
$PM_{2.5}$ [b]	7.6	0.0022	0.0098	0.0022	0.0098	0.0034	0.0147	2.62	11.47
Hazardous Air Pollutants									
Benzene [c]	2.10E-03	6.18E-07	2.71E-06	6.18E-07	2.71E-06	9.26E-07	4.06E-06	0.00072	0.0032
Toluene [c]	3.40E-03	1.00E-06	4.38E-06	1.00E-06	4.38E-06	1.50E-06	6.57E-06	0.0012	0.0051
Hexane [c]	1.80E+00	5.29E-04	2.32E-03	5.29E-04	2.32E-03	7.94E-04	3.48E-03	0.62	2.72
Formaldehyde [c]	7.50E-02	2.21E-05	9.66E-05	2.21E-05	9.66E-05	3.31E-05	1.45E-04	0.026	0.11
Dichlorobenzene [c]	1.20E-03	3.53E-07	1.55E-06	3.53E-07	1.55E-06	5.29E-07	2.32E-06	0.00041	0.0018
Naphthalene [c]	6.10E-04	1.79E-07	7.86E-07	1.79E-07	7.86E-07	2.69E-07	1.18E-06	0.00021	0.00092
POM 2 [c,d,e]	5.90E-05	1.74E-08	7.60E-08	1.74E-08	7.60E-08	2.60E-08	1.14E-07	0.000020	0.000089
POM 3 [c,f]	1.60E-05	4.71E-09	2.06E-08	4.71E-09	2.06E-08	7.06E-09	3.09E-08	0.0000055	0.000024
POM 4 [c,g]	1.80E-06	5.29E-10	2.32E-09	5.29E-10	2.32E-09	7.94E-10	3.48E-09	0.0000006	0.0000027
POM 5 [c,h]	2.40E-06	7.06E-10	3.09E-09	7.06E-10	3.09E-09	1.06E-09	4.64E-09	0.0000008	0.0000036
POM 6 [c,i]	7.20E-06	2.12E-09	9.28E-09	2.12E-09	9.28E-09	3.18E-09	1.39E-08	0.0000025	0.000011
POM 7 [c,j]	1.8E-06	5.29E-10	2.32E-09	5.29E-10	2.32E-09	7.94E-10	3.48E-09	0.0000006	0.0000027
Greenhouse Gases									
CO_2 [l]	119,226	35.07	153.59	35.07	153.59	52.60	230.39	41080	179931
CH_4 [l]	2.25	0.00066	0.0029	0.00066	0.0029	0.0010	0.0043	0.77	3.39
N_2O [l]	0.22	0.000066	0.00029	0.000066	0.00029	0.00010	0.00043	0.077	0.34
CO_2e [m]	---	35.10	153.74	35.10	153.74	52.65	230.61	41,121	180,108

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

KLEINFELDER

Project: GMBU - Alternative B
Date: 7/15/2013

27. Oil Well Fugitives

Number of Producting Wells 579 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.042
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.117
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.015
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	----
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	----
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.00023
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.016
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.050
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-well)						0.37
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**213.43**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.59
Toluene Emissions	0.00011	0.0020	0.53
Ethylbenzene Emissions	----	0.00011	0.028
Xylene Emissions	0.000011	0.00065	0.16
n-Hexane Emissions	0.0035	0.035	9.36

KLEINFELDER	Project: GMBU - Alternative B Date: 7/15/2013

27. Oil Well Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	19	8,760	0.84	0.0027	0.121	0.36	0.0031	7.51
Connectors - Gas	29	8,760	0.84	0.0027	0.017	0.08	0.0007	1.61
Open-Ended Lines - Gas	1	8,760	0.84	0.0027	0.031	0.005	0.00004	0.10
Flanges - Light Oil	32	8,760	0.84	0.0027	0.003	0.015	0.00013	0.31
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						0.59	0.0052	12.47
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**343.68**	**3.01**	**7,220**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

28. Deep Gas Well Fugitive Emissions

Number of Producting Wells 209 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.35
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.08
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.056
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.027
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.015
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.049
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	----
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
VOC EMISSIONS (tons/yr-well)						0.58
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**121.45**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b Weight fractions from wellsite gas analysis and estimates
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction[b]	Liquid Weight Fraction of VOCs[b]	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.33
Toluene Emissions	0.0001	0.0162	0.43
Ethylbenzene Emissions	----	0.0007	0.02
Xylene Emissions	0.00001	0.0058	0.14
n-Hexane Emissions	0.0035	0.0257	2.41

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	49	8,760	0.84	0.0027	0.121	0.92	0.0081	19.36
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.0041	9.83
Open-Ended Lines - Gas	4	8,760	0.84	0.0027	0.031	0.019	0.00017	0.40
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						1.55	0.0135	32.53
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**323.61**	**2.83**	**6799**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

29. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate:	0.4	MMscf/day/well
Wells Requiring Dehydrators:	209	wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
0 % Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
VOC	0.0863	0.378	79.04
Hazardous Air Pollutants			
Benzene	0.00500	0.0220	4.60
Toluene	0.0213	0.0931	19.46
Ethylbenzene	0.00620	0.0273	5.71
Xylenes	0.0443	0.194	40.55
Greenhouse Gases			
CH_4	0.1351	0.592	123.69
CO_2e	2.84	12.43	2597.41

KLEINFELDER

Project: GMBU - Alternative B

Date: 7/15/2013

30. Compressor Station Engines

Assumptions:

Number of new compressor stations 2 facilities

Compressor Engine Capacity 8000 hp

Equations:

Emission Factor (g/hp-hr) = average heat rate of 8,000 btu/hp-hr (8,000/1,000,000 *453.6 = 3.6288 multiplier)

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760\ \text{(hr/yr)}}{453.6\ \text{g/lb} * 2000\ \text{(lb/ton)}}$$

Pollutant	Emission Factor (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions Per Facility (lb/hr-facility)	Emissions Per Facility (tons/yr-facility)	Emissions [i] Total (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	17.64	77.25	154.50
CO [a]	-	2.0	35.27	154.50	308.99
VOC [a]	-	0.7	12.35	54.07	108.15
PM_{10} [b,c]	9.95E-03	0.036	0.64	2.79	5.58
$PM_{2.5}$ [b,c]	9.95E-03	0.036	0.64	2.79	5.58
SO_2 [b]	5.88E-04	0.002	0.038	0.16	0.33
Hazardous Air Pollutants [b]					
Benzene	4.40E-04	1.60E-03	0.014	0.062	0.12
Toluene	4.08E-04	1.48E-03	0.013	0.057	0.11
Ethylbenzene	3.97E-05	1.44E-04	0.0013	0.0056	0.011
Xylenes	1.84E-04	6.68E-04	0.0059	0.026	0.052
n-Hexane	1.11E-03	4.03E-03	0.036	0.16	0.31
Formaldehyde	5.28E-02	1.92E-01	1.69	7.40	14.80
Acetaldehyde	8.36E-03	3.03E-02	0.27	1.17	2.34
Acrolein	5.14E-03	1.87E-02	0.16	0.72	1.44
Methanol	2.50E-03	9.07E-03	0.080	0.35	0.70
1,1,2,2-Tetrachloroethane	4.00E-05	1.45E-04	0.0013	0.0056	0.011
1,1,2-Trichloroethane	3.18E-05	1.15E-04	0.0010	0.0045	0.0089
1,3-Dichloropropene	2.64E-05	9.58E-05	0.00084	0.0037	0.0074
1,3-Butadiene	2.67E-04	9.69E-04	0.0085	0.037	0.075
2,2,4-Trimethylpentane	2.50E-04	9.07E-04	0.0080	0.035	0.070
Biphenyl	2.12E-04	7.69E-04	0.0068	0.030	0.059
Carbon Tetrachloride	3.67E-05	1.33E-04	0.0012	0.0051	0.010
Chlorobenzene	3.04E-05	1.10E-04	0.0010	0.0043	0.0085
Chloroform	2.85E-05	1.03E-04	0.00091	0.0040	0.0080
Ethylene Dibromide	4.43E-05	1.61E-04	0.0014	0.0062	0.012
Methylene Chloride	2.00E-05	7.26E-05	0.00064	0.0028	0.0056
Naphthalene	7.44E-05	2.70E-04	0.0024	0.010	0.021
Phenol	2.40E-05	8.71E-05	0.00077	0.0034	0.0067
Styrene	2.36E-05	8.56E-05	0.00076	0.0033	0.0066
Tetrachloroethane	2.48E-06	9.00E-06	0.000079	0.00035	0.00070
Vinyl Chloride	1.49E-05	5.41E-05	0.00048	0.0021	0.0042
PAH -POM 1 [d,e]	2.69E-05	9.76E-05	0.00086	0.0038	0.0075
POM 2 [d,f]	5.93E-05	2.15E-04	0.0019	0.0083	0.017
Benzo(b)fluoranthene/POM6	1.66E-07	6.02E-07	0.0000053	0.000023	0.000047
Chrysene/POM7	6.93E-07	2.51E-06	0.000022	0.00010	0.00019
Greenhouse Gases					
CO_2 [g]	117	424	7,481	32,766	65,532
CH_4 [g]	0.002	0.0080	0.14	0.62	1.24
N_2O [g]	0.0002	0.00080	0.014	0.062	0.12
CO_2e [h]	---	---	7,488	32,798	65,596

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00, with 50% control from catalyst for HAPs

c PM = sum of PM filterable and PM condensable

d Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP-42 Table 1.4-3 footnotes.

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

h Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

i Assumes maximum development scenario

31. Compressor Station Condensate Tanks

Assumptions:

Average Condensate Production Rate :

Facility Production Rate	73.5	bbls per day per facility
Tank Control Efficiency	95	%
Total Facilities	2	Compressor Stations
Number of Tanks at Comp Station	4	tanks/facility

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS
Controlled by combustion device with 95% efficiency

Component	Tank Emissions (tons/yr/Tank)	Controlled Tank Emissions (tons/yr/Tank)	Total[a] Emissions (tons/yr)
Total VOC	6.52	0.33	2.61
Hazardous Air Pollutants			
Benzene	0.063	0.0032	0.025
Toluene	0.11	0.0053	0.042
Ethylbenzene	0.0046	0.00023	0.0018
Xylenes	0.038	0.0019	0.015
n-Hexane	0.17	0.0084	0.07
Greenhouse Gases			
CO_2	1.32	1.32	10.53
CH_4	6.24	0.31	2.50
CO_2e	132	7.87	62.96

a Assumes maximum development scenario

32. Compressor Station Dehydrator Emissions

Assumptions

Number of Compressor Stations: 2 Stations
Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69	23.38
Hazardous Air Pollutants			
Benzene	0.13	0.56	1.12
Toluene	0.090	0.39	0.79
Ethylbenzene	---	---	---
Xylenes	0.016	0.070	0.14
n-Hexane	0.078	0.34	0.68
Greenhouse Gases			
CH_4	3.28	14.35	28.70
CO_2e	68.81	301.38	602.75

a Assumes maximum development scenario

33. Compressor Station Fugitives

Number of Compressor Stations 2 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	114	8,760	0.19	4.50E-03	9.95E-03	0.95
Valves - Light Oil	28	8,760	0.41	2.50E-03	5.53E-03	0.28
Valves - Heavy Oil	0	8,760	0.41	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	28	8,760	0.41	9.80E-05	2.17E-04	0.011
Connectors - Gas	520	8,760	0.19	2.00E-04	4.42E-04	0.19
Connectors - Light Oil	44	8,760	0.41	2.10E-04	4.64E-04	0.04
Connectors - Heavy Oil	0	8,760	0.41	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	45	8,760	0.41	1.10E-04	2.43E-04	0.019
Open-Ended Lines - Gas	2	8,760	0.19	2.00E-03	4.42E-03	0.0074
Open-Ended Lines - Light Oil	0	8,760	0.41	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.41	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.41	2.50E-04	5.53E-04	---
Flanges - Gas	72	8,760	0.19	3.90E-04	8.62E-04	0.052
Flanges - Light Oil	0	8,760	0.41	1.10E-04	2.43E-04	---
Flanges - Heavy Oil	0	8,760	0.41	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	0	8,760	0.41	2.90E-06	6.41E-06	---
Other - Gas	91	8,760	0.19	8.80E-03	1.94E-02	1.48
Other - Light Oil	0	8,760	0.41	7.50E-03	1.66E-02	---
Other - Heavy Oil	0	8,760	0.41	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	0	8,760	0.41	1.40E-02	3.09E-02	---
Compressor station VOC Emissions (tons/yr)						**3.03**
Total Compressor station VOC Emissions (tons/yr)[d]						**6.05**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components referenced from similar existing facilities

b VOC and HAP weight fractions from wellsite gas analysis and compressor tank emissions

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Liquid Weight Fraction of VOCs	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.012
Toluene Emissions	0.0001	0.016	0.014
Ethylbenzene Emissions	----	0.00070	0.00048
Xylene Emissions	0.00001	0.0058	0.0043
n-Hexane Emissions	0.0035	0.026	0.12

33. Compressor Station Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	170	8,760	0.84	0.0027	0.121	3.20	0.028	67.17
Connectors - Gas	609	8,760	0.84	0.0027	0.017	1.61	0.014	33.81
Open-Ended Lines - Gas	2	8,760	0.84	0.0027	0.031	0.010	0.000084	0.20
Flanges - Light Oil	72	8,760	0.84	0.0027	0.003	0.034	0.00029	0.71
Other - Light Oil	91	8,760	0.84	0.0027	0.3	4.24	0.037	89.14
Compressor station GHG Emissions (tons/yr)						**9.09**	**0.080**	**191.0**
Total Compressor station GHG Emissions (tons/yr)[d]						**18.19**	**0.159**	**382.1**

a Number of components referenced from similar existing facilities

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

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34. Compressor Station Truck Loadout

Assumptions:		
Facility Production Rate	74	bbls per day per facility
Total Compressor Facilities	2	

AP - 42, Chapter 5.2

$L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility	tpy[b]
12.46	0.6	5.2	66	520	4.94	74	2.78	5.56

	tpy-facility[c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.027	0.054
Toluene	0.045	0.090
Ethylbenzene	0.0020	0.0039
Xylenes	0.016	0.032
n-Hexane	0.071	0.14
Greenhouse Gases		
CO2	0.56	1.12
CH4	2.66	5.33
CO2e	56.50	113.0

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60^{o} F.

b Emission for full buildout

c Emissions estimated based on condensate tank analysis

KLEINFELDER

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Date: 7/15/2013

35. Compressor Station Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	5,130	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.075	0.14	6.05E-03	0.00	0.00	0.075	0.14
CO	1.02E-02	0.014	0.026	4.48E-02	0.00	0.00	0.014	0.026
VOC [c]	1.55E-03	0.0022	0.0040	1.61E-03	0.00	0.00	0.0022	0.0040
SO_2	3.07E-05	0.00004	0.00008	1.84E-05	0.00	0.00	0.000043	0.00008
PM_{10}	2.57E-03	0.0036	0.0066	1.31E-04	0.00	0.00	0.0036	0.0066
$PM_{2.5}$	2.50E-03	0.0035	0.0064	1.21E-04	0.00	0.00	0.0035	0.0064
Greenhouse Gases								
CO_2	4.520	6.4	11.6	1.050	0.00	0.00	6.4	11.6
CH_4	2.59E-05	0.00004	0.00007	9.38E-05	0.00	0.00	0.00004	0.00007
N_2O	4.01E-06	0.00001	0.00001	2.68E-05	0.00	0.00	0.00001	0.00001
CO_2e [c]	---	6.4	11.6	---	0.00	0.00	6.4	11.6

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

36. Compressor Station Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of Compressor Stations	2	facilities

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	1.60	2.57	5.13
$PM_{2.5}$	0.17	0.15	0.16	0.26	0.51

Vehicle Type[a]	**Weight (lbs)**	**Round Trips per Day All Facilities**
Haul Trucks	45,000	1
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	1

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.010	0.019	0.037
$PM_{2.5}$	0.0081	0.0081	0.0025	0.0046	0.0092

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

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37. Gas and Oil Separation Facility Generators

Assumptions:

Number of GOSPs	1	Facilities
Generator size	1,945	Horsepower
Number of Generators per GOSP	1	engines/Facility

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp)*8760 (hr/yr)}}{\text{453.6 (g/lb)*2000 (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (tons/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	4.29	18.78	18.78
CO [a]	-	2.0	8.58	37.56	37.56
VOC [a]	-	0.7	3.00	13.15	13.15
PM_{10} [b,d]	1.94E-02	7.92E-02	0.34	1.49	1.49
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.34	1.49	1.49
SO_2 [b]	5.88E-04	2.40E-03	0.010	0.045	0.045
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.014	0.061	0.061
Toluene	5.58E-04	2.28E-03	0.0049	0.021	0.021
Ethylbenzene	2.48E-05	1.01E-04	0.00022	0.0010	0.0010
Xylenes	1.95E-04	7.96E-04	0.0017	0.0075	0.0075
Formaldehyde	2.05E-02	8.37E-02	0.18	0.79	0.79
Acetaldehyde	2.79E-03	1.14E-02	0.024	0.11	0.11
Acrolein	2.63E-03	1.07E-02	0.023	0.10	0.10
Methanol	3.06E-03	1.25E-02	0.027	0.12	0.12
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.00022	0.0010	0.0010
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.00013	0.00059	0.00059
1,3-Dichloropropene	1.27E-05	5.18E-05	0.00011	0.00049	0.00049
1,3-Butadiene	6.63E-04	2.71E-03	0.0058	0.025	0.025
Carbon Tetrachloride	1.77E-05	7.23E-05	0.00015	0.00068	0.00068
Chlorobenzene	1.29E-05	5.27E-05	0.00011	0.00049	0.00049
Chloroform	1.37E-05	5.59E-05	0.00012	0.00053	0.00053
Ethylene Dibromide	2.13E-05	8.70E-05	0.00019	0.00082	0.00082
Methylene Chloride	4.12E-05	1.68E-04	0.00036	0.0016	0.0016
Naphthalene	9.71E-05	3.96E-04	0.00085	0.0037	0.0037
Styrene	1.19E-05	4.86E-05	0.00010	0.00046	0.00046
Vinyl Chloride	7.18E-06	2.93E-05	0.00006	0.00028	0.00028
PAH -POM 1	1.41E-04	5.76E-04	0.0012	0.0054	0.0054
Greenhouse Gases					
CO_2 [e]	117	477.2	2046	8,962	8,962
CH_4 [e]	0.002	0.0090	0.0386	0.17	0.17
N_2O [e]	0.0002	0.00090	0.00386	0.017	0.017
CO_2e [f]	---	---	2048	2048.08	8971

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

38. GOSP Truck Loadout

Assumptions:		
Facility Production Rate	5,000	bbls oil per day per facility
Total Facilities	1	central tank batteries
Control Efficiency	95	%

AP - 42, Chapter 5.2

$$L_L = 12.46 \times S \times P \times M / T$$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility[d]	tpy[b,d]
12.46	0.6	2.8	50	520	2.01	5000	3.86	3.86

	tpy-facility[c,d]	tpy[b,c,d]
Hazardous Air Pollutants		
Benzene	0.012	0.012
Toluene	0.011	0.011
Ethylbenzene	0.00063	0.00063
Xylenes	0.0036	0.0036
n-Hexane	0.19	0.19
Greenhouse Gases		
CO2	0.030	0.030
CH4	0.92	0.92
CO2e	19.44	19.44

Notes:

a Vapor molecular weight and True Vapor Pressure (TVP) of the loaded liquid from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5.

b Emission for full buildout

c Emissions estimated based on oil flashing analysis

d Emissions controlled by 95%

39. GOSP Fugitives

Number of GOSP Facilities 1 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	372	8,760	0.19	4.50E-03	9.95E-03	3.10
Valves - Light Oil	390	8,760	0.69	2.50E-03	5.53E-03	6.53
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	74	8,760	0.69	9.80E-05	2.17E-04	0.049
Connectors - Gas	89	8,760	0.19	2.00E-04	4.42E-04	0.033
Connectors - Light Oil	66	8,760	0.69	2.10E-04	4.64E-04	0.09
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	22	8,760	0.69	1.10E-04	2.43E-04	0.02
Open-Ended Lines - Gas	17	8,760	0.19	2.00E-03	4.42E-03	0.0629
Open-Ended Lines - Light Oil	2	8,760	0.69	1.40E-03	3.09E-03	0.0188
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	---
Flanges - Gas	602	8,760	0.19	3.90E-04	8.62E-04	0.434
Flanges - Light Oil	1142	8,760	0.69	1.10E-04	2.43E-04	0.842
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	213	8,760	0.69	2.90E-06	6.41E-06	0.00414
Other - Gas	8	8,760	0.19	8.80E-03	1.94E-02	0.130
Other - Light Oil	4	8,760	0.69	7.50E-03	1.66E-02	0.201
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-facility)						11.61
TOTAL CTB VOC EMISSIONS (tons/yr)[d]						**11.61**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{2000\ \text{(lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.03
Toluene Emissions	0.00011	0.0020	0.03
Ethylbenzene Emissions	----	0.00011	0.001
Xylene Emissions	0.000011	0.00065	0.008
n-Hexane Emissions	0.0035	0.035	0.46

39. GOSP Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	836	8,760	0.84	0.0027	0.121	15.72	0.138	330.31
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.004	9.83
Open-Ended Lines - Gas	19	8,760	0.84	0.0027	0.031	0.092	0.00080	1.92
Flanges - Light Oil	1957	8,760	0.84	0.0027	0.003	0.913	0.00798	19.17
Other - Light Oil	13	8,760	0.84	0.0027	0.3	0.61	0.0053	12.73
EMISSIONS (tons/yr-facility)						17.80	0.156	373.97
TOTAL CTB GHG EMISSIONS (tons/yr)[d]						**17.80**	**0.16**	**373.97**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

KLEINFELDER

Project: GMBU - Alternative B

Date: 7/15/2013

40. GOSP Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	45,862	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{2000 \text{ (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.67	1.23	6.05E-03	0.00	0.00	0.67	1.23
CO	1.02E-02	0.13	0.23	4.48E-02	0.00	0.00	0.13	0.23
VOC [c]	1.55E-03	0.02	0.04	1.61E-03	0.00	0.00	0.019	0.036
SO_2	3.07E-05	0.000	0.001	1.84E-05	0.00	0.00	0.00039	0.00070
PM_{10}	2.57E-03	0.03	0.06	1.31E-04	0.00	0.00	0.032	0.059
$PM_{2.5}$	2.50E-03	0.03	0.06	1.21E-04	0.00	0.00	0.031	0.057
Greenhouse Gases								
CO_2	4.520	56.8	103.6	1.050	0.00	0.00	56.8	103.6
CH_4	2.59E-05	0.0003	0.001	9.38E-05	0.00	0.00	0.0003	0.001
N_2O	4.01E-06	0.0001	0.0001	2.68E-05	0.00	0.00	0.0001	0.0001
CO_2e [c]	---	56.8	103.7	---	0.00	0.00	56.8	103.7

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

KLEINFELDER	Project: GMBU - Alternative B Date: 7/15/2013

41. GOSP Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of GOSP Facilities	1	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day All Facilities
Haul Trucks	45,000	5
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	5

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-facility**	**ton/year-facility**	**ton/year**
PM_{10}	1.72	1.51	16.04	25.67	25.67
$PM_{2.5}$	0.17	0.15	1.604	2.567	2.57

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-facility**	**ton/year-facility**	**ton/year**
PM_{10}	0.033	0.033	0.10	0.19	0.19
$PM_{2.5}$	0.0081	0.0081	0.025	0.046	0.046

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

42. Gas Processing Plant Compression

Assumptions:

Number of compressors	4	engines
Compressor horsepower	300	hp/engine

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr) * Power (hp)*8760 (hr/yr)}}{\text{453.6 (g/lb)*2000 (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (ton/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	0.66	2.90	11.59
CO [a]	-	2.0	1.32	5.79	23.17
VOC [a]	-	0.7	0.46	2.03	8.11
PM_{10} [b,d]	1.94E-02	7.92E-02	0.052	0.23	0.92
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.052	0.23	0.92
SO_2 [b]	5.88E-04	2.40E-03	0.0016	0.0070	0.028
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.0021	0.0093	0.037
Toluene	5.58E-04	2.28E-03	0.00075	0.0033	0.013
Ethylbenzene	2.48E-05	1.01E-04	0.000033	0.00015	0.00059
Xylenes	1.95E-04	7.96E-04	0.00026	0.0012	0.0046
Formaldehyde	2.05E-02	8.37E-02	0.028	0.12	0.48
Acetaldehyde	2.79E-03	1.14E-02	0.0038	0.016	0.066
Acrolein	2.63E-03	1.07E-02	0.0036	0.016	0.062
Methanol	3.06E-03	1.25E-02	0.0041	0.018	0.072
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.000034	0.00015	0.00060
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.000021	0.000090	0.00036
1,3-Dichloropropene	1.27E-05	5.18E-05	0.000017	0.000075	0.00030
1,3-Butadiene	6.63E-04	2.71E-03	0.00090	0.0039	0.016
Carbon Tetrachloride	1.77E-05	7.23E-05	0.000024	0.00010	0.00042
Chlorobenzene	1.29E-05	5.27E-05	0.000017	0.000076	0.00031
Chloroform	1.37E-05	5.59E-05	0.000018	0.000081	0.00032
Ethylene Dibromide	2.13E-05	8.70E-05	0.000029	0.00013	0.00050
Methylene Chloride	4.12E-05	1.68E-04	0.000056	0.00024	0.0010
Naphthalene	9.71E-05	3.96E-04	0.00013	0.00057	0.0023
Styrene	1.19E-05	4.86E-05	0.000016	0.000070	0.00028
Vinyl Chloride	7.18E-06	2.93E-05	0.000010	0.000042	0.00017
PAH -POM 1	1.41E-04	5.76E-04	0.00019	0.00083	0.0033
Greenhouse Gases					
CO_2 [e]	117	477.2	315.59	1382	5529.1
CH_4 [e]	0.002	9.00E-03	0.0060	0.026	0.10
N_2O [e]	0.0002	9.00E-04	0.00060	0.003	0.010
CO_2e [f]	---	---	315.9	1384	5535

a 40 CFR Part 60 Subpart JJJJ compliant engines
b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst
c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr
d PM = sum of PM filterable and PM condensable
e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.
f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.
g Estimated at full project production.

Project: GMBU - Alternative B

Date: 7/15/2013

43. Gas Processing Plant Dehydrator Emissions

Assumptions

Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69
Hazardous Air Pollutants		
Benzene	0.13	0.56
Toluene	0.090	0.39
Ethylbenzene	---	---
Xylenes	0.016	0.070
n-Hexane	0.078	0.34
Greenhouse Gases		
CH_4	3.28	14.35
CO_2e	68.81	301.38

a Assumes maximum development scenario

44. Gas Processing Plant Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	72	8,760	0.19	4.50E-03	9.95E-03	0.60
Connectors - Gas	247	8,760	0.19	2.00E-04	4.42E-04	0.091
Open-Ended Lines - Gas	9	8,760	0.19	2.00E-03	4.42E-03	0.033
Other - Gas	5	8,760	0.19	8.80E-03	1.94E-02	0.081
Total Gas Processing Plant VOC Emissions (tons/yr)[d]						**0.81**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{2000 \text{ (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.00086
Toluene Emissions	0.00011	0.00045
Ethylbenzene Emissions	----	----
Xylene Emissions	0.000011	0.000045
n-Hexane Emissions	0.0035	0.015

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	72	8,760	0.84	0.0027	0.121	1.35	0.012	28.45
Connectors - Gas	247	8,760	0.84	0.0027	0.017	0.65	0.0057	13.71
Open-Ended Lines - Gas	9	8,760	0.84	0.0027	0.031	0.043	0.00038	0.91
Other	5	8,760	0.84	0.0027	0.3	0.23	0.0020	4.90
Total Gas Processing Plant GHG Emissions (tons/yr)[d]						**2.05**	**0.018**	**43.07**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

Project: GMBU - Alternative B
Date: 7/15/2013

45. Water Treatment Facility Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :		
Facility Production Rate	160	bbls oil per day per facility
Total Facilities	1	water treatment facilities
No. Tanks at each facility	6	Tanks per facility
Throughput	2,452,800	gallons per year per facility
Throughput	408,800	gallons per year per tank

Calculations:
Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Tank Work / Breathing (tons/yr/tank)	Tank Work / Breathing (tons/yr/facility)	Total[a] Emissions (tons/yr)
Total VOC	1.02	6.10	6.10
Hazardous Air Pollutants			
Benzene	0.0032	0.019	0.019
Toluene	0.0030	0.018	0.018
Ethylbenzene	0.00017	0.00099	0.0010
Xylenes	0.0010	0.0057	0.0057
n-Hexane	0.051	0.31	0.31
Greenhouse Gases			
CO_2	0.0079	0.047	0.047
CH_4	0.24	1.46	1.46
CO_2e	5.12	30.70	30.70

a Emissions for full buildout
b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

KLEINFELDER	Project: GMBU - Alternative B Date: 7/15/2013

46. Water Treatment Facility Oil Storage Tank Flashing Emissions

Vent Rate =	**1241.60 scf/day-facility**

Vent rate = Gas to oil ratio * production per facility

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (scf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	482.91	3.73
Ethane	30.07	16.516	4.97	0.132	205.06	2.97
Propane	44.10	16.909	7.46	0.198	209.94	4.45
i-Butane	58.12	3.694	2.15	0.057	45.86	1.28
n-Butane	58.12	9.044	5.26	0.140	112.29	3.14
i-Pentane	72.15	3.269	2.36	0.063	40.59	1.41
n-Pentane	72.15	4.297	3.10	0.082	53.35	1.85
Cyclopentane	70.10	0.361	0.25	0.0067	4.48	0.15
Hexanes	86.18	2.285	1.97	0.052	28.37	1.18
Heptanes	100.20	1.423	1.43	0.038	17.67	0.85
Octanes	114.23	0.403	0.46	0.012	5.00	0.27
Nonanes	128.26	0.076	0.10	0.0026	0.94	0.058
Decanes +	142.29	0.026	0.037	0.0010	0.323	0.022
Benzene	78.11	0.106	0.083	0.0022	1.32	0.049
Toluene	92.14	0.083	0.076	0.0020	1.03	0.046
Ethylbenzene	106.17	0.004	0.0042	0.00011	0.0497	0.0025
Xylenes	106.17	0.023	0.024	0.00065	0.286	0.015
n-Hexane	86.18	1.513	1.30	0.035	18.79	0.78
Nitrogen	28.01	0.612	0.17	0.0046	7.60	0.10
Carbon Dioxide	44.01	0.460	0.20	0.0054	5.71	0.12
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**0.692**	**540.29**	**15.56**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**21.47**	**0.89**
TOTAL		**100.00**	**37.63**	**1.000**	**1241.58**	**22.47**

Number of Water Treatment Facilities	**1**

Total Flashing Emissions for All Tanks (tons/yr)

VOC	15.56
Hazardous Air Pollutants	
Benzene	0.049
Toluene	0.046
Ethylbenzene	0.0025
Xylenes	0.015
n-Hexane	0.78
HAPs	0.89
Greenhouse Gases	
CO2	0.12
CH4	3.73
CO2e	78.3

47. Water Treatment Facility Fugitives

Number Water Treatment Facilities 1 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	19	8,760	0.19	4.50E-03	9.95E-03	0.16
Valves - Light Oil	29	8,760	0.69	2.50E-03	5.53E-03	0.49
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	29	8,760	0.69	9.80E-05	2.17E-04	0.019
Connectors - Gas	66	8,760	0.19	2.00E-04	4.42E-04	0.024
Connectors - Light Oil	99	8,760	0.69	2.10E-04	4.64E-04	0.14
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	99	8,760	0.69	1.10E-04	2.43E-04	0.073
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	1	8,760	0.69	1.40E-03	3.09E-03	0.0094
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	1	8,760	0.69	2.50E-04	5.53E-04	0.0017
Flanges - Gas	3	8,760	0.19	3.90E-04	8.62E-04	0.0022
Flanges - Light Oil	5	8,760	0.69	1.10E-04	2.43E-04	0.0037
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	5	8,760	0.69	2.90E-06	6.41E-06	0.00010
VOC EMISSIONS (tons/yr-facility)						0.92
TOTAL Water Treatment VOC EMISSIONS (tons/yr)[d]						**0.92**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.003
Toluene Emissions	0.00011	0.0020	0.002
Ethylbenzene Emissions	----	0.00011	0.0001
Xylene Emissions	0.000011	0.00065	0.0007
n-Hexane Emissions	0.0035	0.0346	0.04

47. Water Treatment Facility Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	77	8,760	0.84	0.0027	0.121	1.45	0.013	30.42
Connectors - Gas	264	8,760	0.84	0.0027	0.017	0.70	0.0061	14.65
Open-Ended Lines - Gas	3	8,760	0.84	0.0027	0.031	0.014	0.00013	0.30
Flanges - Light Oil	13	8,760	0.84	0.0027	0.003	0.0061	0.000053	0.13
EMISSIONS (tons/yr-facility)						2.17	0.019	45.51
TOTAL Water Treatment GHG EMISSIONS (tons/yr)[d]						**2.17**	**0.02**	**45.5**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

KLEINFELDER	Project: GMBU - Alternative B Date: 7/15/2013

48. Water Treatment Plant Generator

Assumptions:

Number of facilities	1	
Generator horsepower	1,945	hp/engine

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}*8760 \text{ (hr/yr)}}{453.6 \text{ (g/lb)}*2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (ton/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	4.29	18.78	18.78
CO [a]	-	2.0	8.58	37.56	37.56
VOC [a]	-	0.7	3.00	13.15	13.15
PM_{10} [b,d]	1.94E-02	7.92E-02	0.34	1.49	1.49
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.34	1.49	1.49
SO_2 [b]	5.88E-04	2.40E-03	0.010	0.045	0.045
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.014	0.061	0.061
Toluene	5.58E-04	2.28E-03	0.0049	0.021	0.021
Ethylbenzene	2.48E-05	1.01E-04	0.00022	0.0010	0.0010
Xylenes	1.95E-04	7.96E-04	0.0017	0.0075	0.0075
Formaldehyde	2.05E-02	8.37E-02	0.18	0.79	0.79
Acetaldehyde	2.79E-03	1.14E-02	0.024	0.11	0.11
Acrolein	2.63E-03	1.07E-02	0.023	0.10	0.10
Methanol	3.06E-03	1.25E-02	0.027	0.12	0.12
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.00022	0.0010	0.0010
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.00013	0.00059	0.00059
1,3-Dichloropropene	1.27E-05	5.18E-05	0.00011	0.00049	0.00049
1,3-Butadiene	6.63E-04	2.71E-03	0.0058	0.025	0.025
Carbon Tetrachloride	1.77E-05	7.23E-05	0.00015	0.00068	0.00068
Chlorobenzene	1.29E-05	5.27E-05	0.00011	0.00049	0.00049
Chloroform	1.37E-05	5.59E-05	0.00012	0.00053	0.00053
Ethylene Dibromide	2.13E-05	8.70E-05	0.00019	0.00082	0.0008
Methylene Chloride	4.12E-05	1.68E-04	0.00036	0.0016	0.0016
Naphthalene	9.71E-05	3.96E-04	0.00085	0.0037	0.0037
Styrene	1.19E-05	4.86E-05	0.00010	0.00046	0.00046
Vinyl Chloride	7.18E-06	2.93E-05	0.000063	0.00028	0.00028
PAH -POM 1	1.41E-04	5.76E-04	0.0012	0.0054	0.0054
Greenhouse Gases					
CO_2 [e]	117	477.2	2,046	8,962	8,962
CH_4 [e]	0.002	9.00E-03	0.039	0.17	0.17
N_2O [e]	0.0002	9.00E-04	0.0039	0.017	0.017
CO_2e [f]	---	---	2,048	8,971	8,971

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

KLEINFELDER

Project: GMBU - Alternative B

Date: 7/15/2013

49. Central Facility Heater Emissions

Assumptions

GOSP Heater Size	11	MMbtu/hr
Number of Heaters at each GOSP	3	heaters
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Gas Processing Plant Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Development size	1	GOSP Facilities
	2	Compressor Stations
	1	Gas Processing Plant

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	GOSP Heater Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	3.24	14.17	100	0.147	0.64	3.68	16.10
CO [a]	84	2.72	11.90	84	0.124	0.54	3.09	13.53
VOC [b]	5.5	0.18	0.78	5.5	0.008	0.04	0.20	0.89
SO_2 [b]	0.6	0.019	0.085	0.6	0.001	0.00	0.022	0.097
PM_{10} [b]	7.6	0.25	1.08	7.6	0.011	0.05	0.28	1.22
$PM_{2.5}$ [b]	7.6	0.25	1.08	7.6	0.011	0.05	0.28	1.22
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.79E-05	2.98E-04	2.10E-03	3.09E-06	1.35E-05	0.000077	0.00034
Toluene [c]	3.40E-03	1.10E-04	4.82E-04	3.40E-03	5.00E-06	2.19E-05	0.00013	0.00055
Hexane [c]	1.80E+00	5.82E-02	2.55E-01	1.80E+00	2.65E-03	1.16E-02	0.066	0.29
Formaldehyde [c]	7.50E-02	2.43E-03	1.06E-02	7.50E-02	1.10E-04	4.83E-04	0.0028	0.012
Dichlorobenzene [c]	1.2E-03	3.88E-05	1.70E-04	1.2E-03	1.76E-06	7.73E-06	0.000044	0.00019
Naphthalene [c]	6.1E-04	1.97E-05	8.64E-05	6.1E-04	8.97E-07	3.93E-06	0.000022	0.000098
POM 2 [c,d,e]	5.9E-05	1.91E-06	8.36E-06	5.9E-05	8.68E-08	3.80E-07	0.0000022	0.000010
POM 3 [c,f]	1.6E-05	5.18E-07	2.27E-06	1.6E-05	2.35E-08	1.03E-07	0.00000059	0.0000026
POM 4 [c,g]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	##########	0.00000029
POM 5 [c,h]	2.4E-06	7.76E-08	3.40E-07	2.4E-06	3.53E-09	1.55E-08	##########	0.00000039
POM 6 [c,i]	7.2E-06	2.33E-07	1.02E-06	7.2E-06	1.06E-08	4.64E-08	0.00000026	0.0000012
POM 7 [c,j]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	##########	0.00000029
Greenhouse Gases								
CO_2 [l]	119,226	3857.30	16894.98	119,226	175.3	767.95	4383	19199
CH_4 [l]	2.25	0.073	0.32	2.25	0.0033	0.014	0.083	0.36
N_2O [l]	0.22	0.0073	0.03	0.22	0.00033	0.0014	0.0083	0.036
CO_2e [m]	---	3861.1	16911.5	---	175.50	768.71	4388	19218

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

KLEINFELDER

Project: GMBU - Alternative B
Date: 7/15/2013

50. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations	2	
Number of GOSPs	1	
Number of Gas Plants	1	

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-facility)	Total Emissions (tons/yr-facility)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	3.57
CO [a]	0.37	1.11	4.86	19.45
Greenhouse Gases				
CO_2 [b]	---	508	2,227	8,906
CH_4 [b]	---	3.2	14.2	56.9
N_2O [b]	---	0.0007	0.003	0.01
CO_2e [b]	---	577	2,526	10,104

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate:	0.4000 MMSCF/day
Glycol Losses with Dry Gas:	0.0012 lb/hr
Wet Gas Water Content:	Saturated
Calculated Wet Gas Water Content:	31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification		
User Identification:	GMBU Alt B Oil Tanks	
City:	Duchesne	
State:	Utah	
Company:	Newfield Exploration	
Type of Tank:	Vertical Fixed Roof Tank	
Description:	One (1) 400 bbl Storage Tank	
Tank Dimensions		
Shell Height (ft):		20.00
Diameter (ft):		12.00
Liquid Height (ft) :		19.00
Avg. Liquid Height (ft):		10.00
Volume (gallons):		16,074.56
Turnovers:		4.18
Net Throughput(gal/yr):		67,151.00
Is Tank Heated (y/n):	N	
Paint Characteristics		
Shell Color/Shade:	Gray/Light	
Shell Condition	Good	
Roof Color/Shade:	Gray/Light	
Roof Condition:	Good	
Roof Characteristics		
Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		0.00
Breather Vent Settings		
Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMBU Alt B Oil Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMBU Alt B Oil Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	0.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	175.6845
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	67,151.0000
Annual Turnovers:	4.1775
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,057.0581

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMBU Alt B Oil Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	175.68	881.37	1,057.06

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification	
User Identification:	GMBU Water treatment tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 500 bbl Storage Tank
Tank Dimensions	
Shell Height (ft):	25.00
Diameter (ft):	12.00
Liquid Height (ft) :	24.00
Avg. Liquid Height (ft):	12.00
Volume (gallons):	20,304.71
Turnovers:	20.13
Net Throughput(gal/yr):	408,800.00
Is Tank Heated (y/n):	N
Paint Characteristics	
Shell Color/Shade:	Gray/Light
Shell Condition	Good
Roof Color/Shade:	Gray/Light
Roof Condition:	Good
Roof Characteristics	
Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00
Breather Vent Settings	
Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations	
Standing Losses (lb):	962.6416
Vapor Space Volume (cu ft):	1,527.3376
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3229
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,527.3376
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	13.5046
Tank Shell Height (ft):	25.0000
Average Liquid Height (ft):	12.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3229
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	13.5046

Working Losses (lb):	1,069.5271
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	408,800.0000
Annual Turnovers:	20.1333
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	20,304.7110
Maximum Liquid Height (ft):	24.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	2,032.1687

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	1,069.53	962.64	2,032.17

50 MMscfd

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

50 MMscfd

Calculated Absorber Stages:	2.51
Specified Dry Gas Dew Point:	5.00 lbs. H_2O/MMSCF
Temperature:	125.0 deg. F
Pressure:	800.0 psig
Dry Gas Flow Rate:	50.0000 MMSCF/day
Glycol Losses with Dry Gas:	1.8232 lb/hr
Wet Gas Water Content:	Saturated
Calculated Wet Gas Water Content:	137.42 lbs. H_2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00 gal/lb H_2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

	50 MMscfd	
2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

50 MMscfd

Flow Rate: 1.46e+001 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

50 MMscfd		
Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

APPENDIX D

ALTERNATIVE C – FIELD WIDE ELECTRIFICATION EMISSIONS

APPENDIX D-1

FIELD WIDE ELECTRIFICATION ALERNATIVE OIL WELL EMISSIONS

Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative C - Oil Wells [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	6.9	2.6	0.6	0.0002	5.8	1.4
	Drilling	83.9	83.9	4.7	0.2	147.4	16.0
	Completion	38.1	18.9	6.8	0.023	265.9	28.1
	Interim Reclamation	0.6	0.7	0.05	0.0006	3.2	0.3
	Wind Erosion	---	---	---	---	1.1	0.2
Wellsite Production Emissions	Production Heaters	327.0	274.6	18.0	2.0	24.8	24.8
	Wellsite Tanks	---	---	1,714.2	---	---	---
	Pneumatics	---	---	397.9	---	---	---
	Fugitives	---	---	1,198.0	---	---	---
	Wellsite Truck Loading	---	---	203.7	---	---	---
	Wellsite Flares	1.7	9.4	---	---	---	---
	Operations Vehicle	15.9	6.8	0.6	0.010	385.8	39.6
Water Treatment Facilities	Water Treatment Oil Tanks	---	---	281.5	---	---	---
	Water Treatment Fugitives	---	---	12.0	---	---	---
Gas and Oil Separation Plants	GOSP Heaters	170.0	142.8	9.4	1.0	12.9	12.9
	GOSP Fugitives	---	---	139.3	---	---	---
	GOSP Flare	10.7	58.3	---	---	---	---
	GOSP Truck Loadout and Vehicle Traffic	15.3	2.9	46.8	0.01	326.5	33.6
Compressor Station Emissions	Compressor Station Tanks	---	---	5.2	---	---	---
	Compressor Station Dehydrator	---	---	46.8	---	---	---
	Compressor Station Truck Loading and Vehicle Traffic	0.3	0.1	11.1	0.0	5.2	0.5
	Compressor Station Dehydrator Heater	2.6	2.2	0.1	0.0	0.2	0.2
	Compressor Station Flare	3.6	19.4	---	---	---	---
	Compressor Station Fugitives	---	---	12.1	---	---	---
	Electric Substation Gas Turbines	47.6	43.5	16.6	0.9	31.8	31.8
	Total Emissions	**724.3**	**666.1**	**4,125.3**	**4.1**	**1,210.6**	**189.6**

a Emissions in summary tables may vary slightly due to rounding differences.

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b]					Total
	Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
Criteria Pollutants & VOC						
NO_X	6.9	83.9	38.1	0.6	---	129.6
CO	2.6	83.9	18.9	0.7	---	106.0
VOC	0.6	4.7	6.8	0.05	---	12.1
SO_2	0.0002	0.2	0.02	0.0006	---	0.2
PM_{10}	5.8	147.4	265.9	3.2	1.1	423.3
$PM_{2.5}$	1.4	16.0	28.1	0.3	0.2	46.0
Hazardous Air Pollutants						
Benzene	---	0.07	0.012	---	---	0.084
Toluene	---	0.03	0.005	---	---	0.031
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.02	0.0018	---	---	0.020
n-Hexane	---	---	0.095	---	---	0.095
Formaldehyde	---	0.007	0.0006	---	---	0.0080
Acetaldehyde	---	0.002	0.00020	---	---	0.0026
Acrolein	---	0.0007	0.00006	---	---	0.00080
Naphthalene	---	0.012	0.0010	---	---	0.013
POM 2	---	0.007	0.0006	---	---	0.0078
POM 5	---	0.00006	0.000005	---	---	0.000061
POM 6	---	0.0002	0.000019	---	---	0.00024
POM 7	---	0.0001	0.000012	---	---	0.00016
Greenhouses Gases						
CO_2	171.7	15,975	2,565	63	---	18,776
CH_4	0.001	0.64	18.17	0.002	---	18.81
N_2O	0.0003	0.13	0.02	0.0007	---	0.15
CO_2e	171.8	16,029	2,954	64	---	19,218

a Assumes maximum development scenario of 204 wells in one year
b Emissions in summary tables may vary slightly due to rounding differences.
c Total drilling emissions includes Tier IV drill rig engines

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Total Project Production Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]							
	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Wellsite Flares	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC								
NO_X	327.0	---	---	---	---	1.7	15.9	344.6
CO	274.6	---	---	---	---	9.4	6.8	290.9
VOC	18.0	1714.2	1198.0	203.7	397.9	---	0.6	3,532.4
SO_2	2.0	---	---	---	---	---	0.010	2.0
PM_{10}	24.8	---	---	---	---	---	385.8	410.6
$PM_{2.5}$	24.8	---	---	---	---	---	39.6	64.4
Hazardous Air Pollutants								
Benzene	0.0069	5.45	3.31	0.65	0.42	---	---	9.84
Toluene	0.011	5.03	2.97	0.60	0.22	---	---	8.83
Ethylbenzene	---	0.28	0.16	0.03	---	---	---	0.47
Xylene	---	1.61	0.92	0.19	0.022	---	---	2.74
n-Hexane	5.89	85.79	52.55	10.19	7.35	---	---	161.77
Formaldehyde	0.25	---	---	---	---	---	---	0.25
Acetaldehyde	---	---	---	---	---	---	---	---
Acrolein	---	---	---	---	---	---	---	---
Methanol	---	---	---	---	---	---	---	---
1,1,2,2-Tetrachloroethane	---	---	---	---	---	---	---	---
1,1,2-Trichloroethane	---	---	---	---	---	---	---	---
1,3-Dichloropropene	---	---	---	---	---	---	---	---
1,3-Butadiene	---	---	---	---	---	---	---	---
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	---
Biphenyl	---	---	---	---	---	---	---	---
Carbon Tetrachloride	---	---	---	---	---	---	---	---
Chlorobenzene	---	---	---	---	---	---	---	---
Chloroform	---	---	---	---	---	---	---	---
Dichlorobenzene	0.0039	---	---	---	---	---	---	0.0039
Ethylene Dibromide	---	---	---	---	---	---	---	---
Methylene Chloride	---	---	---	---	---	---	---	---
Naphthalene	0.0020	---	---	---	---	---	---	0.0020
Phenol	---	---	---	---	---	---	---	---
Styrene	---	---	---	---	---	---	---	---
Vinyl Chloride	---	---	---	---	---	---	---	---
PAH -POM 1	---	---	---	---	---	---	---	---
POM 2	0.00019	---	---	---	---	---	---	0.00019
POM 3	0.000052	---	---	---	---	---	---	0.000052
POM 4	0.0000059	---	---	---	---	---	---	0.0000059
POM 5	0.0000078	---	---	---	---	---	---	0.0000078
POM 6	0.000024	---	---	---	---	---	---	0.000024
POM 7	0.0000059	---	---	---	---	---	---	0.0000059
Greenhouse Gases								
CO_2	389,813	22.8	16.9	1.58	12.29	3,257	1,391	394,514
CH_4	7.35	410.5	1929.1	48.78	1,403	10.0	0.0155	3,809
N_2O	0.74	---	---	---	---	0.0033	0.0035	0.74
CO_2e	390,195	8,643	40,529	1,026	29,474	3,468	1,392	474,727

a Assumes maximum development scenario of 3250 wells
b Emissions in summary tables may vary slightly due to rounding differences.

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Total Project Infrastructure Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]								
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Central Facility Flares	Dehydrators	Gas Turbines	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	172.6	---	---	---	14.3	---	47.61	15.6	250.1
CO	145.0	---	---	---	77.8	---	43.46	3.0	269.2
VOC	9.5	286.7	163.4	57.4	---	46.8	16.57	0.5	580.8
SO_2	1.0	---	---	---	---	---	0.93	0.01	2.0
PM_{10}	13.1	---	---	---	---	---	31.84	331.7	376.7
$PM_{2.5}$	13.1	---	---	---	---	---	31.84	34.2	79.1
Hazardous Air Pollutants									
Benzene	0.004	0.95	0.41	0.26	---	2.24	0.069	---	3.92
Toluene	0.006	0.91	0.36	0.32	---	1.58	0.75	---	3.91
Ethylbenzene	---	0.050	0.018	0.015	---	---	0.18	---	0.267
Xylene	---	0.29	0.11	0.11	---	0.28	0.37	---	1.16
n-Hexane	3.11	14.22	6.30	2.60	---	1.36	---	---	27.59
Formaldehyde	0.13	---	---	---	---	---	4.08	---	4.21
Acetaldehyde	---	---	---	---	---	---	0.23	---	0.23
Acrolein	---	---	---	---	---	---	0.037	---	0.037
Methanol	---	---	---	---	---	---	---	---	---
1,1,2,2-Tetrachloroethane	---	---	---	---	---	---	---	---	---
1,1,2-Trichloroethane	---	---	---	---	---	---	---	---	---
1,3-Dichloropropene	---	---	---	---	---	---	---	---	---
1,3-Butadiene	---	---	---	---	---	---	0.0025	---	0.0025
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	---	---
Biphenyl	---	---	---	---	---	---	---	---	---
Carbon Tetrachloride	---	---	---	---	---	---	---	---	---
Chlorobenzene	---	---	---	---	---	---	---	---	---
Chloroform	---	---	---	---	---	---	---	---	---
Dichlorobenzene	0.0021	---	---	---	---	---	---	---	0.0021
Ethylene Dibromide	---	---	---	---	---	---	---	---	---
Methylene Chloride	---	---	---	---	---	---	---	---	---
Naphthalene	0.0011	---	---	---	---	---	0.0075	---	0.0085
Phenol	---	---	---	---	---	---	---	---	---
Propylene Oxide	---	---	---	---	---	---	0.17	---	0.17
Styrene	---	---	---	---	---	---	---	---	---
Tetrachloroethane	---	---	---	---	---	---	---	---	---
Vinyl Chloride	---	---	---	---	---	---	---	---	---
PAH -POM 1	---	---	---	---	---	---	0.013	---	0.013
POM 2	0.00010	---	---	---	---	---	---	---	0.00010
POM 3	0.000028	---	---	---	---	---	---	---	0.00003
POM 4	0.0000031	---	---	---	---	---	---	---	0.000003
POM 5	0.0000041	---	---	---	---	---	---	---	0.000004
POM 6	0.000012	---	---	---	---	---	---	---	0.000012
POM 7	0.000003	---	---	---	---	---	---	---	0.000003
Greenhouse Gases									
CO_2	205,812	23.25	2.4	2.248	35,625	---	775,466	1,315	1,018,246
CH_4	3.88	72.40	278.1	10.65	228	57.40	14.6	0.008	664.6
N_2O	0.39	---	---	---	0.05	---	1.5	0.001	1.9
CO_2e	206,013	1,544	5,843	226	40,418	1,206	776,227	1,316	1,032,792

a Assumes maximum development scenario of 3250 wells

b Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU - Alternative C - Oil Wells

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Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	129.6	344.6	250.1	724.3
CO	106.0	290.9	269.2	666.1
VOC	12.1	3,532.4	580.8	4,125.3
SO_2	0.2	2.0	2.0	4.1
PM_{10}	423.3	410.6	376.7	1,210.6
$PM_{2.5}$	46.0	64.4	79.1	189.6
Hazardous Air Pollutants				
Benzene	0.084	9.84	3.92	13.84
Toluene	0.031	8.83	3.91	12.78
Ethylbenzene	---	0.47	0.27	0.74
Xylene	0.020	2.74	1.16	3.92
n-Hexane	0.095	161.77	27.59	189.46
Formaldehyde	0.0080	0.25	4.21	4.47
Acetaldehyde	0.0026	---	0.23	0.23
Acrolein	0.00080	---	0.037	0.038
Methanol	---	---	---	---
1,1,2,2-Tetrachloroethane	---	---	---	---
1,1,2-Trichloroethane	---	---	---	---
1,3-Dichloropropene	---	---	---	---
1,3-Butadiene	---	---	0.0025	0.0025
2,2,4-Trimethylpentane	---	---	---	---
Biphenyl	---	---	---	---
Carbon Tetrachloride	---	---	---	---
Chlorobenzene	---	---	---	---
Chloroform	---	---	---	---
Dichlorobenzene	---	0.0039	0.0021	0.0060
Ethylene Dibromide	---	---	---	---
Methylene Chloride	---	---	---	---
Naphthalene	0.013	0.0020	0.0085	0.024
Phenol	---	---	---	---
Propylene Oxide	---	---	0.17	0.17
Styrene	---	---	---	---
Vinyl Chloride	---	---	---	---
(PAH) POM 1	---	---	0.013	0.013
POM 2	0.0078	0.00019	0.00010	0.0081
POM 3	---	0.000052	0.00003	0.00008
POM 4	---	0.0000059	0.000003	0.000009
POM 5	0.000061	0.0000078	0.000004	0.000073
POM 6	0.00024	0.000024	0.000012	0.00028
POM 7	0.00016	0.0000059	0.000003	0.00016
Total HAPs	0.26	183.91	41.53	225.69
Greenhouse Gases				
CO_2	18,776	394,514	1,018,246	1,431,536
CH_4	18.81	3,809	665	4,492
N_2O	0.15	0.74	1.90	2.80
CO_2e	19218	474,727	1,032,792	1,526,737

a Emissions for Peak Field Development
b Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU - Alternative C - Oil Wells

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1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	3	days per well pad
	12	hours per day
	36	hours per well pad
Annual amount of well pads	47	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			**Backhoe Emissions [a]**			**Total**
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.035	1.67	1.97	0.035	1.67	3.33
PM_{15}	0.50	0.009	0.42	0.50	0.009	0.42	0.85
PM_{10}	0.38	0.007	0.32	0.38	0.007	0.32	0.64
$PM_{2.5}$	0.21	0.004	0.18	0.21	0.004	0.18	0.35

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

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2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	3	day grading per well pad
	12	hours/day
	36	hours per well pad
Deep gas well pads	0	well pads/year
Oil well pads	47	well pads/year
Distance graded - Oil well	1.19	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Oil wells			Total Emissions
	lbs/well	lbs/hr/well pad	tons/well pad	tons/year[a]
TSP	3.21	0.09	0.0016	0.075
PM_{15}	1.53	0.043	0.00077	0.036
PM_{10}	0.92	0.026	0.00046	0.022
$PM_{2.5}$	0.10	0.003	0.000050	0.0023

a Assumes maximum development scenario

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3. Road Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	4	days per mile
	12	hours per day
	0.19	miles of road per well pad
	9	hours per well pad road
Annual amount of well pads with roads	47	pads with roads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3} * \text{Control Efficiency}$

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} * \text{Control Efficiency}$

Emissions = 1.97 lbs TSP/hour/piece of equipment
Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.009	0.41	1.97	0.009	0.41	0.83
PM_{15}	0.50	0.002	0.11	0.50	0.002	0.11	0.21
PM_{10}	0.38	0.002	0.08	0.38	0.002	0.08	0.16
$PM_{2.5}$	0.21	0.0009	0.04	0.21	0.001	0.04	0.087

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.
b Assumes maximum development scenario

4. Road Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	9	hours per well pad roads
Road construction grading distance	0.37	miles road per well pad
Annual well pads	47	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Roads			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	1.00	0.11	0.0005	0.024
PM_{15}	0.48	0.05	0.00024	0.011
PM_{10}	0.29	0.032	0.00014	0.0068
$PM_{2.5}$	0.03	0.003	0.000016	0.00073

a Assumes maximum development scenario

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5. Pipeline Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	10	days per mile
	12	hours per day
	0.19	miles of pipeline per well pad
	22	hours per well pad pipeline
Annual amount of well pads withpipeline	47	pads with pipeline/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content } \%)^{1.2} * (\text{soil moisture content } \%)^{-1.3}$* Control Efficiency
Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4}$ * Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment
Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.022	1.04	1.97	0.022	1.04	2.07
PM_{15}	0.50	0.006	0.26	0.50	0.006	0.26	0.53
PM_{10}	0.38	0.0042	0.20	0.38	0.0042	0.20	0.40
$PM_{2.5}$	0.21	0.0023	0.11	0.21	0.0023	0.11	0.22

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.
b Assumes maximum development scenario

6. Pipeline Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	22	hours per well pad pipeline
Pipeline construction grading distance	0.75	miles pipeline per well pad
Annual well pads	47	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Pipeline			Total Emissions
	lbs/well	lbs/hr/well pad	tons/well pad	tons/year[a]
TSP	2.00	0.09	0.0010	0.047
PM_{15}	0.96	0.043	0.00048	0.023
PM_{10}	0.58	0.026	0.00029	0.014
$PM_{2.5}$	0.06	0.0028	0.000031	0.0015

a Assumes maximum development scenario

KLEINFELDER	Project: GMBU - Alternative C - Oil Wells Date: 7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual
$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual
$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily
$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily
$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction Emissions

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of pads per year	47	well pads/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	1.20	1.05	5.61	0.09	4.16
$PM_{2.5}$	0.12	0.11	0.56	0.009	0.42

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	0.015	0.014	0.023	0.00040	0.02
$PM_{2.5}$	0.0036	0.0035	0.0056	0.00010	0.005

Drilling - Oil Wells

Hours per day	24	hour/day
Days per oil well	6	day/well
Number of wells per year	204	wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	3
Light Trucks	8,000	5
Mean Vehicle Weight	25,000	---
Total Round Trips	---	11

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	1.32	1.16	11.29	0.71	145.36
$PM_{2.5}$	0.13	0.12	1.13	0.07	14.54

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	0.018	0.018	0.052	0.0036	0.74
$PM_{2.5}$	0.0045	0.0043	0.013	0.0009	0.18

KLEINFELDER	Project: GMBU - Alternative C - Oil Wells Date: 7/15/2013

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S) 5.1 AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles 19
Precipitation Days (P) 45 days per year (NCDC data for Ouray, UT 1955-2004)
W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles 6
Precipitation Days (P) 45 days per year
W = average weight in tons of vehicles traveling the road

Interim Reclamation

Hours per day 12 hour/day
Days per pad 3 day/well pad
Number of wells per year 47 wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	1.35	1.19	4.21	0.07	3.13
$PM_{2.5}$	0.14	0.12	0.42	0.007	0.31

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	0.019	0.019	0.020	0.00035	0.02
$PM_{2.5}$	0.0047	0.0046	0.0049	0.00009	0.004

Completion - Oil Well

Hours per day 24 hour/day
Days per oil well 7 day/well
Number of wells per year 204 wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	7
Haul Trucks	45,000	2
Light Trucks	8,000	7
Mean Vehicle Weight	28,813	---
Total Round Trips	---	16

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	1.41	1.23	17.50	1.29	262.95
$PM_{2.5}$	0.14	0.12	1.75	0.13	26.29

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	0.021	0.020	0.087	0.007	1.44
$PM_{2.5}$	0.0052	0.0050	0.021	0.0017	0.35

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	Paved Total tons/year	Total tons/year
PM_{10}	415.60	2.21	417.81
$PM_{2.5}$	41.56	0.54	42.10

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

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8. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	377	acres total disturbance for roads and pipelines per year
	1,523,892	square meters total initial disturbance for roads and pipelines
	94	acres total disturbance for well pads per year
	380,404	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed (U_{10}^{+})	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\ U_{10}^{+}$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, $P = 0$ for $U^*< U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	2.14	0.00
PM_{10}	1.07	0.00
$PM_{2.5}$	0.16	0.00

9. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction	3	days per well pad
Well pads per year	47	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.18	0.16
CO	1.98E-02	0.041	0.00074	7.26E-02	0.30	0.0054	0.34	0.29
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.021	0.018
SO_2	4.57E-05	0.000095	0.0000017	2.83E-05	0.00012	0.0000021	0.00021	0.00018
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00080	0.000014	0.010	0.008
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00074	0.000013	0.0092	0.008
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	6.67	0.12	20.61	17.44
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00086	0.000016	0.0010	0.0008
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00033	0.0000060	0.00036	0.0003
CO_2e [d]	---	13.95	0.25	---	6.79	0.12	20.75	17.55

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	47	new pads per year
Backhoe miles per pad	0.58	miles (Value assumed to be 1/4 of dozer or grader mileage)
Backhoe Hours	67.3	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer miles per pad	2.3	miles
Dozer Hours	67.3	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader miles per pad	2.3	miles
Motor Grader Hours	67.3	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horse Power} * \text{Hours} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)
Criteria Pollutants & VOC									
NOx	6.9	0.28	0.0094	8.38	1.48	0.050	8.38	2.52	0.085
CO	3.49	0.14	0.0047	2.7	0.48	0.016	2.70	0.81	0.027
VOC [b]	0.99	0.040	0.0013	0.68	0.12	0.0041	0.68	0.20	0.0069
PM_{10}	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
$PM_{2.5}$	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
Greenhouse Gases									
CO_2 [c]	188.2	7.59	0.26	188.2	33.31	1.12	188.2	56.59	1.91
CO_2e [e]	---	7.59	0.26	---	33.31	1.12	---	56.59	1.91

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC		
NOx	4.28	6.77
CO	1.43	2.26
VOC	0.36	0.58
PM_{10}	0.22	0.35
$PM_{2.5}$	0.22	0.35
Greenhouse Gases		
CO_2	97.50	154.26
CO_2e [e]	97.50	154.26

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor: 73.96 kg CO_2/mmBtu
393 hp-hr = mmBtu
188.2 g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

KLEINFELDER	Project: GMBU - Alternative C - Oil Wells Date: 7/15/2013

11. Drilling Tailpipe Emissions

Assumptions:

Number of oil wells drilled	204	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	144	hours per site (oil well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (oil well)
Number of Pickup Trips	5	trips/day-well (oil well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	**Heavy Haul Trucks-Oil Wells**			**Heavy Duty Pickups-Oil Wells**			**Total-Oil Wells** [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.033	7.39E-03	0.038	0.0028	0.50	7.35
CO	1.98E-02	0.12	0.0089	7.26E-02	0.38	0.027	0.50	7.33
VOC [c]	3.16E-03	0.020	0.0014	3.54E-03	0.018	0.0013	0.038	0.56
SO_2	4.57E-05	0.00028	0.000020	2.83E-05	0.00015	0.000011	0.00043	0.0063
PM_{10}	4.22E-03	0.026	0.0019	1.94E-04	0.0010	0.000072	0.027	0.40
$PM_{2.5}$	4.09E-03	0.025	0.0018	1.79E-04	0.00093	0.000067	0.026	0.39
Greenhouse Gases								
CO_2	6.73E+00	41.83	3.01	1.61E+00	8.34	0.60	50.17	736.83
CH_4	6.56E-05	0.00041	0.000029	2.08E-04	0.0011	0.000078	0.0015	0.022
N_2O	1.20E-05	0.000075	0.0000054	8.05E-05	0.00042	0.000030	0.00049	0.0072
CO_2e [d]	---	41.86	3.01	---	8.49	0.61	50.35	739.53

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

KLEINFELDER	Project: GMBU - Alternative C - Oil Wells Date: 7/15/2013

12. Completion Tailpipe Emissions

Assumptions:

Number of oil wells	204	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	168	hours per site (oil well)
Number of Heavy Diesel Truck Trips	9	trips/day-well (oil well)
Number of Pickup Trips	7	trips/day-well (oil well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	**Heavy Haul Trucks-Oil Wells**			**Heavy Duty Pickups-Oil Wells**			**Total_Oil Wells** [c]	
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/hr)	(tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.69	0.058	7.39E-03	0.054	0.0045	0.75	12.80
CO	1.98E-02	0.18	0.016	7.26E-02	0.53	0.044	0.71	12.18
VOC [c]	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.055	0.94
SO_2	4.57E-05	0.00043	0.000036	2.83E-05	0.00021	0.000017	0.00063	0.011
PM_{10}	4.22E-03	0.039	0.0033	1.94E-04	0.0014	0.00012	0.041	0.70
$PM_{2.5}$	4.09E-03	0.038	0.0032	1.79E-04	0.0013	0.00011	0.039	0.68
Greenhouse Gases								
CO_2	6.73E+00	62.74	5.27	1.61E+00	11.67	0.98	74.41	1275.16
CH_4	6.56E-05	0.00061	0.000051	2.08E-04	0.0015	0.00013	0.0021	0.036
N_2O	1.20E-05	0.00011	0.0000094	8.05E-05	0.00058	0.000049	0.00070	0.012
CO_2e [d]	---	62.79	5.27	---	11.89	1.00	74.67	1279.62

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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Project: GMBU - Alternative C - Oil Wells

Date: 7/15/2013

13. Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	204	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/well) * Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.169	0.62
CO	1.98E-02	0.041	0.00074	7.26E-02	0.15	0.0027	0.19	0.70
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.0139	0.051
SO_2	4.57E-05	0.00009	0.0000017	2.83E-05	0.000059	0.0000011	0.00015	0.00056
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00040	0.0000072	0.0091	0.034
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00037	0.0000067	0.0088	0.032
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	3.34	0.060	17.28	63.44
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00043	0.0000078	0.00057	0.0021
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00017	0.0000030	0.00019	0.00070
CO_2e [d]	---	13.95	0.25	---	3.40	0.061	17.35	63.71

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

14. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation	144	hours/oil well
Development Rate	204	oil wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

$$\text{Emissions (ton/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{horsepower (hp)} * \text{Hours (hour/year)} * \text{Load factor}}{\text{2000 lb/ton}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1, 10/96

Drill Rig Emissions (Tier 4)

Species	Drill Rig E. Factor (lb/hp-hr)	Drill Rig Emissions (lb/hr)	Oil Well Drill Rig Emissions (tons/yr-well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC				
NOx [a]	5.73E-03	5.21	0.38	76.53
CO [a]	5.73E-03	5.21	0.38	76.53
VOC [a]	3.09E-04	0.28	0.02	4.12
PM_{10} [a]	6.61E-05	0.06	0.004	0.88
$PM_{2.5}$ [a]	6.61E-05	0.06	0.004	0.88
SO_2 [b]	1.21E-05	0.011	0.00079	0.16
Hazardous Air Pollutants				
Benzene [c]	5.43E-06	0.0049	0.00036	0.073
Toluene [c]	1.97E-06	0.0018	0.00013	0.026
Xylenes [c]	1.35E-06	0.0012	0.000088	0.018
Formaldehyde [c]	5.52E-07	0.00050	0.000036	0.0074
Acetaldehyde [c]	1.76E-07	0.00016	0.000012	0.0024
Acrolein [c]	5.52E-08	0.00005	0.0000036	0.00074
Naphthalene [d]	9.10E-07	0.00083	0.000060	0.012
POM 2 [d,e,f]	5.39E-07	0.00049	0.000035	0.0072
POM 5 [d,e,g]	4.22E-09	0.0000038	0.00000028	0.000056
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000011	0.00022
POM 7 [d,e,i]	1.07E-08	0.000010	0.00000070	0.00014
Greenhouse Gases				
CO_2 [j]	1.14	1037.47	74.70	15,238
CH_4 [j,k]	4.63E-05	0.042	0.0030	0.62
N_2O [j,k]	9.26E-06	0.0084	0.00061	0.12
CO_2e [m]	---	1040.96	74.95	15,290

a Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM) Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.
b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1
c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr
d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr
e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene
g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.
h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.
i POM 7 includes: Chrysene.
j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.
k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.
l Assumes maximum development scenario
m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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15. Well Fracturing Engine

Average Gallons of Diesel used per Frac Job	566	gallons/well (oil well)
Hours per frac job	25.2	hours/well (oil well)
Development Rate - Oil Wells	204	wells/year (oil wells)
Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

Emissions (tons/year) = $\frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

Species	Frac Engine Emissions				
	E. Factor (lb/MMBtu)	**E. Factor (lb/hp-hr)**	**Engine Emissions (lb/hr)**	**Engine Emissions (tons/yr-well)**	**Emissions [k] (tons/yr)**
Criteria Pollutants & VOC					
NOx [a]	3.2	0.024	9.84	0.12	25.32
CO [a]	0.85	5.50E-03	2.62	0.033	6.72
VOC [a]	0.09	7.05E-04	0.28	0.0035	0.71
PM_{10} [a]	0.10	0.0007	0.31	0.0039	0.79
$PM_{2.5}$ [a]	0.10	0.0007	0.31	0.0039	0.79
SO_2 [a]	1.52E-03	1.21E-05	0.0047	0.000059	0.012
Hazardous Air Pollutants					
Benzene [b]	7.76E-04	5.43E-06	0.0024	0.000030	0.0061
Toluene [b]	2.81E-04	1.97E-06	0.00086	0.000011	0.0022
Xylenes [b]	1.93E-04	1.35E-06	0.00059	0.0000075	0.0015
Formaldehyde [b]	7.89E-05	5.52E-07	0.00024	0.0000031	0.00062
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000078	0.0000010	0.00020
Acrolein [b]	7.88E-06	5.52E-08	0.000024	0.00000031	0.000062
Naphthalene [c]	1.30E-04	9.10E-07	0.00040	0.0000050	0.0010
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00024	0.0000030	0.00061
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000019	0.000000023	0.0000048
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000073	0.000000092	0.000019
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000047	0.000000059	0.000012
Greenhouse Gases					
CO_2 [i]	163.05	1.14	501.6	6.32	1289.9
CH_4 [j]	6.61E-03	4.63E-05	0.020	0.00026	0.052
N_2O [j]	1.32E-03	9.26E-06	0.0041	0.000051	0.010
CO_2e [l]	---	---	503.3	6.3	1,294.3

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

16. Oil Well Development Venting

Following completion, oil wells are vented prior to connnection to the gathering pipeline. Gas wells are connected to a sales line during completion.

Amount of Vented Gas:	5.0	Mscf per well (Average volume estimated)
Development Rate:	204	oil wells per year
Control Rate	0	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/well)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.04	83.858	13.453	0.674	4.193	8.86E-02	18.08
Ethane	30.07	7.944	2.389	0.120	0.397	1.57E-02	3.21
Propane	44.10	4.313	1.902	0.095	0.216	1.25E-02	2.56
i-Butane	58.12	0.687	0.399	0.020	0.034	2.63E-03	0.54
n-Butane	58.12	1.284	0.746	0.037	0.064	4.92E-03	1.00
i-Pentane	72.15	0.332	0.240	0.012	0.017	1.58E-03	0.32
n-Pentane	72.15	0.375	0.270	0.014	0.019	1.78E-03	0.36
Hexanes	86.18	0.134	0.116	0.00580	0.0067	7.63E-04	0.16
Heptanes	100.20	0.055	0.055	0.00274	0.0027	3.60E-04	0.074
Octanes	114.23	0.0085	0.010	0.00049	0.0004	6.40E-05	0.013
Nonanes	128.26	0.00080	0.001	0.00005	0.00004	6.76E-06	0.0014
Decanes +	142.29	0.00010	0.0001	0.00001	0.00001	9.37E-07	0.00019
Benzene	78.12	0.0052	0.004	0.00020	0.0003	2.68E-05	0.0055
Toluene	92.13	0.0023	0.002	0.00011	0.0001	1.40E-05	0.0028
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.00001	0.00001	1.40E-06	0.00029
n-Hexane	86.18	0.082	0.070	0.00353	0.0041	4.64E-04	0.095
Helium	4.00	----	---	---	---	---	---
Nitrogen	28.01	0.647	0.181	0.00908	0.0323	1.19E-03	0.24
Carbon Dioxide	44.01	0.268	0.118	0.00591	0.0134	7.76E-04	0.16
Oxygen	32.00	----	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.00009	0.0003	1.12E-05	0.0023
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.4**	**0.025**	**5.13**
HAP Subtotal		**0.09**	**0.08**	**0.004**	**0.004**	**0.0005**	**0.10**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**26.82**

a Assumes maximum development scenario

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17. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

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18. Operations Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	575,626	miles/year-all wells
Operation Pickup Truck Mileage:	171,615	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	8.45	15.43	6.05E-03	0.28	0.52	8.74	15.95
CO	1.02E-02	1.61	2.94	4.48E-02	2.11	3.84	3.71	6.78
VOC [c]	1.55E-03	0.24	0.45	1.61E-03	0.08	0.14	0.32	0.58
SO_2	3.07E-05	0.005	0.009	1.84E-05	0.0009	0.0016	0.006	0.010
PM_{10}	2.57E-03	0.41	0.74	1.31E-04	0.006	0.011	0.41	0.75
$PM_{2.5}$	2.50E-03	0.39	0.72	1.21E-04	0.006	0.010	0.40	0.73
Greenhouse Gases								
CO_2	4.520	712.8	1,300.9	1.050	49.4	90.1	762.2	1,391.0
CH_4	2.59E-05	0.0041	0.007	9.38E-05	0.004	0.008	0.008	0.016
N_2O	4.01E-06	0.0006	0.0012	2.68E-05	0.0013	0.0023	0.0019	0.0035
CO_2e [c]	---	713.1	1,301.4	---	49.9	91.0	763.0	1392.4

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

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19. Operations Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of wells not producing to GOSP	1450	wells

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	63
Light Trucks	8,000	19
Mean Vehicle Weight	36,457	---
Total Round Trips	---	82

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.56	1.37	0.16	0.26	382.52
$PM_{2.5}$	0.16	0.14	0.016	0.026	38.25

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.027	0.027	0.00094	0.0017	2.47
$PM_{2.5}$	0.0066	0.0066	0.00023	0.00042	0.61

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

20. Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	13,195	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	1088	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	362	well pads
Control Efficiency of tanks:	95	%
Average Throughput:	92,959	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.56	0.028	836.80
Hazardous Air Pollutants [b]			
Benzene	0.0018	0.000089	2.66
Toluene	0.0017	0.000083	2.46
Ethylbenzene	0.000092	0.0000046	0.14
Xylenes	0.00053	0.000026	0.78
n-Hexane	0.028	0.0014	41.88
Greenhouse Gases [b]			
CO_2	0.0044	0.0044	9.51
CH_4	0.13	0.0067	200.37
CO_2e	2.83	0.15	4217.32

a Total wellsite working and breathing emissions are based on 1452 uncontrolled tanks and 724 tanks controlled at 95%.
b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

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21. Oil Storage Tank Flashing Emissions

Assumptions:

Oil Production Rate :	13,195	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	1088	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	362	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 102.39 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT PERCENT	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	16.58	39.82	307.20
Ethane	30.07	16.516	4.97	13.20	16.91	244.55
Propane	44.10	16.909	7.46	19.81	17.31	367.19
i-Butane	58.12	3.694	2.15	5.71	3.78	105.72
n-Butane	58.12	9.044	5.26	13.97	9.26	258.83
i-Pentane	72.15	3.269	2.36	6.27	3.35	116.14
n-Pentane	72.15	4.297	3.10	8.24	4.40	152.66
Cyclopentane	70.10	0.361	0.25	0.67	0.37	12.46
Hexanes	86.18	2.285	1.97	5.23	2.34	96.97
Heptanes	100.20	1.423	1.43	3.79	1.46	70.21
Octanes	114.23	0.403	0.46	1.22	0.41	22.67
Nonanes	128.26	0.076	0.10	0.26	0.078	4.80
Decanes +	142.29	0.026	0.037	0.098	0.027	1.82
Benzene	78.11	0.106	0.083	0.22	0.109	4.08
Toluene	92.14	0.083	0.076	0.20	0.085	3.77
Ethylbenzene	106.17	0.004	0.004	0.011	0.0041	0.21
Xylenes	106.17	0.023	0.024	0.065	0.0236	1.20
n-Hexane	86.18	1.513	1.30	3.46	1.55	64.21
Nitrogen	28.01	0.612	0.17	0.46	0.63	8.44
Carbon Dioxide	44.01	0.460	0.20	0.54	0.47	9.97
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**69.23**	**44.56**	**1282.94**
HAP SUBTOTAL		**1.73**	**1.49**	**3.96**	**1.77**	**73.46**
TOTAL		**100.0**	**37.63**	**100.0**	**102.39**	**1853.10**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	856.08	21.34	877.42
Hazardous Air Pollutants [b]			
Benzene	2.72	0.068	2.79
Toluene	2.51	0.063	2.58
Ethylbenzene	0.14	0.0035	0.14
Xylenes	0.80	0.020	0.82
n-Hexane	42.84	1.07	43.91
Greenhouse Gases [b]			
CO_2	6.65	6.65	13.30
CH_4	204.99	5.11	210.10
CO_2e	4311.40	113.97	4425.4

a Total wellsite flashing emissions are based on 1452 uncontrolled tanks and 724 tanks controlled at 95%.

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22. Oil Truck Loadout

Assumptions:

Oil Well Production Rate	9.1	bbl/day-well
Number of Oil Wells not going to a GOSP	1450	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [b]
Oil Loading [a]	0.6	2.8	50	520	2.01	9.1	0.14	203.70

	Oil Loading tpy-well [c]	Oil Loading tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.00045	0.65
Toluene	0.00041	0.60
Ethylbenzene	0.000023	0.033
Xylenes	0.00013	0.19
n-Hexane	0.0070	10.19
Greenhouse Gases		
CO2	0.00109	1.58
CH4	0.034	48.78
CO2e	0.71	1025.9

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60^{o}F.

b Assumes maximum development scenario

c Emissions estimated based on flashing analysis weight fractions

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23. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.00080	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.0023	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.320

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Proposed Action	3,250	397.90	1,402.92	12.29	29,474

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

24. Production Heater Emissions

Assumptions

Oil Wellsite Separator Heater Size	500	Mbtu/hr
Oil Wellsite Tank Heater Size	250	Mbtu/hr per tank
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Oil wells with heater treaters	1450	wells
Oil well tanks	2,176	tanks
Load Factor	0.6	load rate

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Oil Well Separator Heater			Oil Well Tank Heaters			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Total Emissions (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.029	0.13	100	0.029	0.13	74.65	326.95
CO [a]	84	0.025	0.11	84	0.025	0.11	62.70	274.64
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	4.11	17.98
SO_2 [b]	0.6	0.00018	0.00077	0.6	0.00018	0.00077	0.45	1.96
PM_{10} [b]	7.6	0.0022	0.0098	7.6	0.0022	0.0098	5.67	24.85
$PM_{2.5}$ [b]	7.6	0.0022	0.0098	7.6	0.0022	0.0098	5.67	24.85
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.18E-07	2.71E-06	2.10E-03	6.18E-07	2.71E-06	0.0016	0.0069
Toluene [c]	3.40E-03	1.00E-06	4.38E-06	3.40E-03	1.00E-06	4.38E-06	0.0025	0.011
Hexane [c]	1.80E+00	5.29E-04	2.32E-03	1.80E+00	5.29E-04	2.32E-03	1.34	5.89
Formaldehyde [c]	7.50E-02	2.21E-05	9.66E-05	7.50E-02	2.21E-05	9.66E-05	0.056	0.25
Dichlorobenzene [c]	1.20E-03	3.53E-07	1.55E-06	1.20E-03	3.53E-07	1.55E-06	0.00090	0.0039
Naphthalene [c]	6.10E-04	1.79E-07	7.86E-07	6.10E-04	1.79E-07	7.86E-07	0.00046	0.0020
POM 2[c,d,e]	5.90E-05	1.74E-08	7.60E-08	5.90E-05	1.74E-08	7.60E-08	0.000044	0.00019
POM 3[c,f]	1.60E-05	4.71E-09	2.06E-08	1.60E-05	4.71E-09	2.06E-08	0.000012	0.000052
POM 4[c,g]	1.80E-06	5.29E-10	2.32E-09	1.80E-06	5.29E-10	2.32E-09	0.000001	0.000006
POM 5[c,h]	2.40E-06	7.06E-10	3.09E-09	2.40E-06	7.06E-10	3.09E-09	0.000002	0.000008
POM 6[c,i]	7.20E-06	2.12E-09	9.28E-09	7.20E-06	2.12E-09	9.28E-09	0.000005	0.000024
POM 7[c,j]	1.8E-06	5.29E-10	2.32E-09	1.8E-06	5.29E-10	2.32E-09	0.000001	0.000006
Greenhouse Gases								
CO_2 [l]	119,226	35.07	153.59	119,226	35.07	153.59	88,998	389,813
CH_4 [l]	2.25	0.00066	0.0029	2.25	0.00066	0.0029	1.68	7.35
N_2O [l]	0.22	0.000066	0.00029	0.22	0.000066	0.00029	0.17	0.74
CO_2e [m]	---	35.10	153.74	---	35.10	153.74	89,086	390,195

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

25. Oil Well Fugitives

Number of Producting Wells 3250 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.042
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.117
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.015
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	----
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	----
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.00023
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.016
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.050
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-well)						0.37
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**1198.00**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	3.31
Toluene Emissions	0.00011	0.0020	2.97
Ethylbenzene Emissions	----	0.00011	0.16
Xylene Emissions	0.000011	0.00065	0.92
n-Hexane Emissions	0.0035	0.035	52.55

25. Oil Well Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	19	8,760	0.84	0.0027	0.121	0.36	0.0031	7.51
Connectors - Gas	29	8,760	0.84	0.0027	0.017	0.08	0.0007	1.61
Open-Ended Lines - Gas	1	8,760	0.84	0.0027	0.031	0.005	0.00004	0.10
Flanges - Light Oil	32	8,760	0.84	0.0027	0.003	0.015	0.00013	0.31
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						0.59	0.0052	12.47
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**1929.15**	**16.88**	**40,529**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

26. Wellsite Flare Emissions

Assumptions:

Number of oil well pads with controls	362	well pads
Vent gas from each well pad	7.66	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.02	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [c] (lb/hr)	Total Emissions [c] (tons/yr)
Criteria Pollutants					
NOx [a]	0.068	0.0011	0.005	0.40	1.73
CO [a]	0.37	0.006	0.026	2.15	9.44
Greenhouse Gases					
CO2 [b]	---	2.05	9.00	744	3,257
CH4 [b]	---	0.0063	0.028	2.28	10.00
N2O [b]	---	0.000002	0.000009	0.0008	0.0033
CO2e [b]	---	2.19	9.58	792	3,468

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

27. Compressor Station Condensate Tanks

Assumptions:

Average Condensate Production Rate :

Facility Production Rate	73.5	bbls per day per facility
Tank Control Efficiency	95	%
Total Facilities	4	Compressor Stations
Number of Tanks at Comp Station	4	tanks/facility

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS
Controlled by combustion device with 95% efficiency

Component	Tank Emissions (tons/yr/Tank)	Controlled Tank Emissions (tons/yr/Tank)	Total[a] Emissions (tons/yr)
Total VOC	6.52	0.33	5.21
Hazardous Air Pollutants			
Benzene	0.063	0.0032	0.051
Toluene	0.11	0.0053	0.085
Ethylbenzene	0.0046	0.00023	0.0037
Xylenes	0.038	0.0019	0.030
n-Hexane	0.17	0.0084	0.13
Greenhouse Gases			
CO_2	1.32	1.32	21.07
CH_4	6.24	0.31	4.99
CO_2e	132	7.87	125.92

a Assumes maximum development scenario

28. Compressor Station Dehydrator Emissions

Assumptions

Number of Compressor Stations 4 Stations
Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69	46.77
Hazardous Air Pollutants			
Benzene	0.13	0.56	2.24
Toluene	0.090	0.39	1.58
Ethylbenzene	---	---	---
Xylenes	0.016	0.070	0.28
n-Hexane	0.078	0.34	1.36
Greenhouse Gases			
CH_4	3.28	14.35	57.40
CO_2e	68.81	301.38	1205.50

a Assumes maximum development scenario

29. Compressor Station Fugitives

Number of Compressor Stations 4 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	114	8,760	0.19	4.50E-03	9.95E-03	0.95
Valves - Light Oil	28	8,760	0.41	2.50E-03	5.53E-03	0.28
Valves - Heavy Oil	0	8,760	0.41	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	28	8,760	0.41	9.80E-05	2.17E-04	0.011
Connectors - Gas	520	8,760	0.19	2.00E-04	4.42E-04	0.19
Connectors - Light Oil	44	8,760	0.41	2.10E-04	4.64E-04	0.04
Connectors - Heavy Oil	0	8,760	0.41	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	45	8,760	0.41	1.10E-04	2.43E-04	0.019
Open-Ended Lines - Gas	2	8,760	0.19	2.00E-03	4.42E-03	0.0074
Open-Ended Lines - Light Oil	0	8,760	0.41	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.41	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.41	2.50E-04	5.53E-04	---
Flanges - Gas	72	8,760	0.19	3.90E-04	8.62E-04	0.052
Flanges - Light Oil	0	8,760	0.41	1.10E-04	2.43E-04	---
Flanges - Heavy Oil	0	8,760	0.41	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	0	8,760	0.41	2.90E-06	6.41E-06	---
Other - Gas	91	8,760	0.19	8.80E-03	1.94E-02	1.48
Other - Light Oil	0	8,760	0.41	7.50E-03	1.66E-02	---
Other - Heavy Oil	0	8,760	0.41	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	0	8,760	0.41	1.40E-02	3.09E-02	---
Compressor station VOC Emissions (tons/yr)						**3.03**
Total Compressor station VOC Emissions (tons/yr)[d]						**12.10**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components referenced from similar existing facilities

b VOC and HAP weight fractions from wellsite gas analysis and compressor tank emissions

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Liquid Weight Fraction of VOCs	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.025
Toluene Emissions	0.0001	0.016	0.028
Ethylbenzene Emissions	----	0.00070	0.0010
Xylene Emissions	0.00001	0.0058	0.0085
n-Hexane Emissions	0.0035	0.026	0.23

29. Compressor Station Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	170	8,760	0.84	0.0027	0.121	3.20	0.028	67.17
Connectors - Gas	609	8,760	0.84	0.0027	0.017	1.61	0.014	33.81
Open-Ended Lines - Gas	2	8,760	0.84	0.0027	0.031	0.010	0.000084	0.20
Flanges - Light Oil	72	8,760	0.84	0.0027	0.003	0.034	0.00029	0.71
Other - Light Oil	91	8,760	0.84	0.0027	0.3	4.24	0.037	89.14
Compressor station GHG Emissions (tons/yr)						**9.09**	**0.080**	**191.0**
Total Compressor station GHG Emissions (tons/yr)[d]						**36.37**	**0.318**	**764.1**

a Number of components referenced from similar existing facilities
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

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30. Compressor Station Truck Loadout

Assumptions:		
Facility Production Rate	74	bbls per day per facility
Total Facilities	4	

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility	tpy[b]
12.46	0.6	5.2	66	520	4.94	74	2.78	11.13

	tpy-facility[c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.027	0.11
Toluene	0.045	0.18
Ethylbenzene	0.0020	0.0078
Xylenes	0.016	0.064
n-Hexane	0.071	0.29
Greenhouse Gases		
CO2	0.56	2.25
CH4	2.66	10.65
CO2e	56.50	226.0

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60^{o} F.

b Emission for full buildout

c Emissions estimated based on condensate tank analysis

31. Compressor Station Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	10,260	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.15	0.27	6.05E-03	0.00	0.00	0.15	0.27
CO	1.02E-02	0.03	0.05	4.48E-02	0.00	0.00	0.03	0.05
VOC [c]	1.55E-03	0.00	0.01	1.61E-03	0.00	0.00	0.00	0.01
SO_2	3.07E-05	0.000	0.000	1.84E-05	0.0000	0.0000	0.000	0.000
PM_{10}	2.57E-03	0.01	0.01	1.31E-04	0.000	0.000	0.01	0.01
$PM_{2.5}$	2.50E-03	0.01	0.01	1.21E-04	0.000	0.000	0.01	0.01
Greenhouse Gases								
CO_2	4.520	12.7	23.2	1.050	0.0	0.0	12.7	23.2
CH_4	2.59E-05	0.0001	0.000	9.38E-05	0.000	0.000	0.000	0.000
N_2O	4.01E-06	0.0000	0.0000	2.68E-05	0.0000	0.0000	0.0000	0.0000
CO_2e [c]	---	12.7	23.2	---	0.0	0.0	12.7	23.2

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

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32. Compressor Station Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of Compressor Stations	4	facilities

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	0.80	1.28	5.13
$PM_{2.5}$	0.17	0.15	0.080	0.13	0.51

Vehicle Type[a]	Weight (lbs)	Round Trips per Day All Facilities
Haul Trucks	45,000	1
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	1

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.0051	0.0094	0.037
$PM_{2.5}$	0.0081	0.0081	0.0013	0.0023	0.0092

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

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33. GOSP Truck Loadout

Assumptions:

Facility Production Rate	5,000	bbls oil per day per facility
Total Facilities	12	central tank batteries
Control Efficiency	95	%

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility[d]	tpy[b,d]
12.46	0.6	2.8	50	520	2.01	5000	3.86	46.31

	tpy-facility[c,d]	tpy[b,c,d]
Hazardous Air Pollutants		
Benzene	0.012	0.15
Toluene	0.011	0.14
Ethylbenzene	0.00063	0.0075
Xylenes	0.0036	0.043
n-Hexane	0.19	2.32
Greenhouse Gases		
CO2	0.030	0.36
CH4	0.92	11.09
CO2e	19.44	233.24

Notes:

a Vapor molecular weight and True Vapor Pressure (TVP) of the loaded liquid from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5.

b Emission for full buildout

c Emissions estimated based on oil flashing analysis

d Emissions controlled by 95%

34. GOSP Fugitives

Number of GOSP Facilities 12 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	372	8,760	0.19	4.50E-03	9.95E-03	3.10
Valves - Light Oil	390	8,760	0.69	2.50E-03	5.53E-03	6.53
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	74	8,760	0.69	9.80E-05	2.17E-04	0.049
Connectors - Gas	89	8,760	0.19	2.00E-04	4.42E-04	0.033
Connectors - Light Oil	66	8,760	0.69	2.10E-04	4.64E-04	0.09
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	22	8,760	0.69	1.10E-04	2.43E-04	0.02
Open-Ended Lines - Gas	17	8,760	0.19	2.00E-03	4.42E-03	0.0629
Open-Ended Lines - Light Oil	2	8,760	0.69	1.40E-03	3.09E-03	0.0188
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	---
Flanges - Gas	602	8,760	0.19	3.90E-04	8.62E-04	0.434
Flanges - Light Oil	1142	8,760	0.69	1.10E-04	2.43E-04	0.842
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	213	8,760	0.69	2.90E-06	6.41E-06	0.00414
Other - Gas	8	8,760	0.19	8.80E-03	1.94E-02	0.130
Other - Light Oil	4	8,760	0.69	7.50E-03	1.66E-02	0.201
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-facility)						11.61
TOTAL CTB VOC EMISSIONS (tons/yr)[d]						**139.32**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.35
Toluene Emissions	0.00011	0.0020	0.30
Ethylbenzene Emissions	----	0.00011	0.015
Xylene Emissions	0.000011	0.00065	0.091
n-Hexane Emissions	0.0035	0.035	5.55

34. GOSP Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	836	8,760	0.84	0.0027	0.121	15.72	0.138	330.31
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.004	9.83
Open-Ended Lines - Gas	19	8,760	0.84	0.0027	0.031	0.092	0.00080	1.92
Flanges - Light Oil	1957	8,760	0.84	0.0027	0.003	0.913	0.00798	19.17
Other - Light Oil	13	8,760	0.84	0.0027	0.3	0.61	0.0053	12.73
EMISSIONS (tons/yr-facility)						17.80	0.156	373.97
TOTAL CTB GHG EMISSIONS (tons/yr)[d]						**213.61**	**1.87**	**4487.60**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

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35. GOSP Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	571,656	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	8.39	15.32	6.05E-03	0.00	0.00	8.39	15.32
CO	1.02E-02	1.60	2.92	4.48E-02	0.00	0.00	1.60	2.92
VOC [c]	1.55E-03	0.24	0.44	1.61E-03	0.00	0.00	0.24	0.44
SO_2	3.07E-05	0.005	0.009	1.84E-05	0.0000	0.0000	0.005	0.009
PM_{10}	2.57E-03	0.40	0.73	1.31E-04	0.000	0.000	0.40	0.73
$PM_{2.5}$	2.50E-03	0.39	0.71	1.21E-04	0.000	0.000	0.39	0.71
Greenhouse Gases								
CO_2	4.520	707.9	1,291.9	1.050	0.0	0.0	707.9	1,291.9
CH_4	2.59E-05	0.0041	0.007	9.38E-05	0.000	0.000	0.004	0.007
N_2O	4.01E-06	0.0006	0.0011	2.68E-05	0.0000	0.0000	0.0006	0.0011
CO_2e [c]	---	708.2	1,292.5	---	0.0	0.0	708.2	1292.5

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

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36. GOSP Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of GOSP Facilities	12	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day All Facilities
Haul Trucks	45,000	63
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	63

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-facility**	**ton/year-facility**	**ton/year**
PM_{10}	1.72	1.51	16.85	26.95	323.44
$PM_{2.5}$	0.17	0.15	1.685	2.695	32.34

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-facility**	**ton/year-facility**	**ton/year**
PM_{10}	0.033	0.033	0.11	0.20	2.36
$PM_{2.5}$	0.0081	0.0081	0.026	0.048	0.58

Notes:

a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

37. Water Treatment Facility Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :

Facility Production Rate	160	bbls oil per day per facility
Total Facilities	13	water treatment facilities
No. Tanks at each facility	6	Tanks per facility
Throughput	2,452,800	gallons per year per facility
Throughput	408,800	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Tank Work / Breathing (tons/yr/tank)	Tank Work / Breathing (tons/yr/facility)	Total[a] Emissions (tons/yr)
Total VOC	1.02	6.097	79.25
Hazardous Air Pollutants			
Benzene	0.0032	0.019	0.25
Toluene	0.0030	0.018	0.23
Ethylbenzene	0.00017	0.00099	0.013
Xylenes	0.0010	0.0057	0.074
n-Hexane	0.051	0.31	3.97
Greenhouse Gases			
CO_2	0.0079	0.047	0.62
CH_4	0.24	1.46	18.98
CO_2e	5.12	30.70	399.14

a Emissions for full buildout

b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

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38. Water Treatment Facility Oil Storage Tank Flashing Emissions

Vent Rate =	1241.60 scf/day-facility

* Gas to oil ratio * production per facility

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (scf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	482.91	3.73
Ethane	30.07	16.516	4.97	0.132	205.06	2.97
Propane	44.10	16.909	7.46	0.198	209.94	4.45
i-Butane	58.12	3.694	2.15	0.057	45.86	1.28
n-Butane	58.12	9.044	5.26	0.140	112.29	3.14
i-Pentane	72.15	3.269	2.36	0.063	40.59	1.41
n-Pentane	72.15	4.297	3.10	0.082	53.35	1.85
Cyclopentane	70.10	0.361	0.25	0.0067	4.48	0.151
Hexanes	86.18	2.285	1.97	0.052	28.37	1.18
Heptanes	100.20	1.423	1.43	0.038	17.67	0.85
Octanes	114.23	0.403	0.46	0.012	5.00	0.275
Nonanes	128.26	0.076	0.10	0.0026	0.94	0.0582
Decanes +	142.29	0.026	0.037	0.0010	0.323	0.0221
Benzene	78.11	0.106	0.083	0.0022	1.32	0.0494
Toluene	92.14	0.083	0.076	0.0020	1.03	0.0457
Ethylbenzene	106.17	0.004	0.0042	0.00011	0.0497	0.00254
Xylenes	106.17	0.023	0.024	0.00065	0.286	0.0146
n-Hexane	86.18	1.513	1.30	0.035	18.79	0.779
Nitrogen	28.01	0.612	0.17	0.0046	7.60	0.102
Carbon Dioxide	44.01	0.460	0.20	0.0054	5.71	0.121
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**0.692**	**540.29**	**15.56**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**21.47**	**0.89**
TOTAL		**100.00**	**37.63**	**1.000**	**1241.58**	**22.47**

Number of Water Treatment Facilities	**13**

Total Flashing Emissions for All Tanks (tons/yr)

VOC	202.24
Hazardous Air Pollutants	
Benzene	0.64
Toluene	0.59
Ethylbenzene	0.033
Xylenes	0.19
n-Hexane	10.12
HAPs	11.58
Greenhouse Gases	
CO2	1.57
CH4	48.43
CO2e	1018.5

39. Water Treatment Facility Fugitives

Number Water Treatment Facilities 13 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	19	8,760	0.19	4.50E-03	9.95E-03	0.16
Valves - Light Oil	29	8,760	0.69	2.50E-03	5.53E-03	0.49
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	29	8,760	0.69	9.80E-05	2.17E-04	0.019
Connectors - Gas	66	8,760	0.19	2.00E-04	4.42E-04	0.024
Connectors - Light Oil	99	8,760	0.69	2.10E-04	4.64E-04	0.14
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	99	8,760	0.69	1.10E-04	2.43E-04	0.073
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	1	8,760	0.69	1.40E-03	3.09E-03	0.0094
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	1	8,760	0.69	2.50E-04	5.53E-04	0.0017
Flanges - Gas	3	8,760	0.19	3.90E-04	8.62E-04	0.0022
Flanges - Light Oil	5	8,760	0.69	1.10E-04	2.43E-04	0.0037
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	5	8,760	0.69	2.90E-06	6.41E-06	0.00010
VOC EMISSIONS (tons/yr-facility)						0.92
TOTAL Water Treatment VOC EMISSIONS (tons/yr)[d]						**11.97**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.033
Toluene Emissions	0.00011	0.0020	0.029
Ethylbenzene Emissions	----	0.00011	0.0016
Xylene Emissions	0.000011	0.00065	0.0091
n-Hexane Emissions	0.0035	0.0346	0.52

39. Water Treatment Facility Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	77	8,760	0.84	0.0027	0.121	1.45	0.013	30.42
Connectors - Gas	264	8,760	0.84	0.0027	0.017	0.70	0.0061	14.65
Open-Ended Lines - Gas	3	8,760	0.84	0.0027	0.031	0.014	0.00013	0.30
Flanges - Light Oil	13	8,760	0.84	0.0027	0.003	0.0061	0.000053	0.13
EMISSIONS (tons/yr-facility)						2.17	0.019	45.51
TOTAL Water Treatment GHG EMISSIONS (tons/yr)[d]						**28.16**	**0.25**	**591.6**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

KLEINFELDER Bright People. Right Solutions.	Project: GMBU - Alternative C - Oil Wells Date: 7/15/2013

40. Central Facility Heater Emissions

Assumptions

GOSP Heater Size	11	MMbtu/hr
Number of Heaters at each GOSP	3	heaters
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Development size	12	GOSP Facilities
	4	Compressor Stations

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	GOSP Heater Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	3.24	14.17	100	0.147	0.64	39.41	172.62
CO [a]	84	2.72	11.90	84	0.124	0.54	33.11	145.00
VOC [b]	5.5	0.18	0.78	5.5	0.008	0.04	2.17	9.49
SO_2 [b]	0.6	0.019	0.085	0.6	0.001	0.00	0.24	1.04
PM_{10} [b]	7.6	0.25	1.08	7.6	0.011	0.05	3.00	13.12
$PM_{2.5}$ [b]	7.6	0.25	1.08	7.6	0.011	0.05	3.00	13.12
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.79E-05	2.98E-04	2.10E-03	3.09E-06	1.35E-05	8.28E-04	0.0036
Toluene [c]	3.40E-03	1.10E-04	4.82E-04	3.40E-03	5.00E-06	2.19E-05	1.34E-03	0.0059
Hexane [c]	1.80E+00	5.82E-02	2.55E-01	1.80E+00	2.65E-03	1.16E-02	7.09E-01	3.11
Formaldehyde [c]	7.50E-02	2.43E-03	1.06E-02	7.50E-02	1.10E-04	4.83E-04	2.96E-02	0.13
Dichlorobenzene [c]	1.2E-03	3.88E-05	1.70E-04	1.2E-03	1.76E-06	7.73E-06	4.73E-04	0.0021
Naphthalene [c]	6.1E-04	1.97E-05	8.64E-05	6.1E-04	8.97E-07	3.93E-06	2.40E-04	0.0011
POM 2[c,d,e]	5.9E-05	1.91E-06	8.36E-06	5.9E-05	8.68E-08	3.80E-07	2.33E-05	0.00010
POM 3[c,f]	1.6E-05	5.18E-07	2.27E-06	1.6E-05	2.35E-08	1.03E-07	6.31E-06	0.000028
POM 4[c,g]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	7.09E-07	0.0000031
POM 5[c,h]	2.4E-06	7.76E-08	3.40E-07	2.4E-06	3.53E-09	1.55E-08	9.46E-07	0.0000041
POM 6[c,i]	7.2E-06	2.33E-07	1.02E-06	7.2E-06	1.06E-08	4.64E-08	2.84E-06	0.000012
POM 7[c,j]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	7.09E-07	0.0000031
Greenhouse Gases								
CO_2 [l]	119,226	3857.30	16894.98	119,226	175.3	767.95	46988.9	205812
CH_4 [l]	2.25	0.073	0.32	2.25	0.0033	0.014	0.89	3.88
N_2O [l]	0.22	0.0073	0.03	0.22	0.00033	0.0014	0.089	0.39
CO_2e [m]	---	3861.1	16911.5	---	175.50	768.71	47035	206013

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

41. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations 4
Number of GOSPs 12

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-facility)	Total Emissions (tons/yr-facility)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	14.30
CO [a]	0.37	1.11	4.86	77.79
Greenhouse Gases				
CO2 [b]	---	508	2,227	35,625
CH4 [b]	---	3.25	14.22	227.52
N2O [b]	---	0.0007	0.003	0.05
CO2e [b]	---	577	2,526	40,418

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

42. Electric Substation Turbines

Assumptions

Number of substations	5	Substations
Size of gas generators	20	MW
Size of steam generators	10	MW
Number of gas turbines per substation	2	turbines/substation
Number of steam turbines per substation	1	turbines/substation
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
20 MW turbine fuel input	189	MMBtu/hr
Turbine load factor	0.8	

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/MMBtu) * Fuel Input (MMBtu/hr) * turbines per facility * load factor * (hrs/year)}}{\text{2000 lbs/ton}}$$

	Emission Factor (lb/MMBtu)	Facility Emissions (lb/hr/facility)	Facility Emissions (tons/yr-facility)	Total Emissions [g] (lb/hr)	Total Emissions [g] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	0.0072	2.17	9.52	10.87	47.61
CO [a]	0.007	1.98	8.69	9.92	43.46
VOC [a]	0.0025	0.76	3.31	3.78	16.57
SO_2 [b]	0.00014	0.042	0.19	0.21	0.93
PM_{10} [c]	0.0048	1.45	6.37	7.27	31.84
$PM_{2.5}$ [c]	0.0048	1.45	6.37	7.27	31.84
Hazardous Air Pollutants [d]					
1,3-Butadiene	4.3E-07	0.00011	0.00049	0.00056	0.0025
Acetaldehyde	4.0E-05	0.011	0.046	0.053	0.23
Acrolein	6.4E-06	0.0017	0.0074	0.008	0.037
Benzene	1.2E-05	0.0032	0.014	0.016	0.069
Ethylbenzene	3.2E-05	0.0084	0.037	0.042	0.18
Formaldehyde	7.1E-04	0.19	0.817	0.93	4.08
Naphthalene	1.3E-06	0.00034	0.0015	0.0017	0.0075
PAH	2.2E-06	0.00058	0.0025	0.0029	0.013
Propylene Oxide	2.9E-05	0.0076	0.033	0.038	0.17
Toluene	1.3E-04	0.034	0.15	0.17	0.75
Xylene	6.4E-05	0.017	0.074	0.08	0.37
Greenhouse Gases					
CO2 [e]	117	35,409	155,093	177,047	775,466
CH_4 [e]	0.002	0.67	2.93	3.34	14.63
N_2O [e]	0.0002	0.067	0.29	0.33	1.46
CO_2e [f]	----	35,444	155,245	177,221	776,227

a Emission factors based on typical turbine specifications for turbines with catalysts to meet BACT levels - (2 ppmv NOx and VOC and 3 ppmv CO)
b Emission factor based on typical turbine manufacturer specifications
c Emission factor based on typical turbine manufacturer specifications and BACT levels
d Emission factors from AP-42, Table 3.1-3, HAPs from natural gas turbines, April 2000, with 13.3% control from the catalyst. Catalyst control efficiency from typical manufacturer data.
e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH4 as 1.0E-03 kg/MMBtu and for N2O as 1.0E-04 kg/MMBtu.
f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.
g Assumes maximum development scenario. Emissions are from the 20 MW turbines as the 10 MW steam generators do not add any additional emissions

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification		
User Identification:	GMBU Water treatment tanks	
City:	Duchesne	
State:	Utah	
Company:	Newfield Exploration	
Type of Tank:	Vertical Fixed Roof Tank	
Description:	One (1) 500 bbl Storage Tank	
Tank Dimensions		
Shell Height (ft):		25.00
Diameter (ft):		12.00
Liquid Height (ft) :		24.00
Avg. Liquid Height (ft):		12.00
Volume (gallons):		20,304.71
Turnovers:		20.13
Net Throughput(gal/yr):		408,800.00
Is Tank Heated (y/n):	N	
Paint Characteristics		
Shell Color/Shade:	Gray/Light	
Shell Condition	Good	
Roof Color/Shade:	Gray/Light	
Roof Condition:	Good	
Roof Characteristics		
Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00
Breather Vent Settings		
Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	962.6416
Vapor Space Volume (cu ft):	1,527.3376
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3229
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,527.3376
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	13.5046
Tank Shell Height (ft):	25.0000
Average Liquid Height (ft):	12.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3229
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	13.5046

Working Losses (lb):	1,069.5271
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	408,800.0000
Annual Turnovers:	20.1333
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	20,304.7110
Maximum Liquid Height (ft):	24.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	2,032.1687

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	1,069.53	962.64	2,032.17

50 MMscfd

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

---

50 MMscfd

Calculated Absorber Stages:	2.51	
Specified Dry Gas Dew Point:	5.00	lbs. H2O/MMSCF
Temperature:	125.0	deg. F
Pressure:	800.0	psig
Dry Gas Flow Rate:	50.0000	MMSCF/day
Glycol Losses with Dry Gas:	1.8232	lb/hr
Wet Gas Water Content:	Saturated	
Calculated Wet Gas Water Content:	137.42	lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00	gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

50 MMscfd		
2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

50 MMscfd

Flow Rate: 1.46e+001 gpm

NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

50 MMscfd		
Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	GMBU PA Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank

Tank Dimensions

Shell Height (ft):		20.00
Diameter (ft):		12.00
Liquid Height (ft) :		19.00
Avg. Liquid Height (ft):		10.00
Volume (gallons):		16,074.56
Turnovers:		5.78
Net Throughput(gal/yr):		92,959.00
Is Tank Heated (y/n):	N	

Paint Characteristics

Shell Color/Shade:	Gray/Light
Shell Condition	Good
Roof Color/Shade:	Gray/Light
Roof Condition:	Good

Roof Characteristics

Type:	Dome	
Height (ft)		1.00
Radius (ft) (Dome Roof)		12.00

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMBU PA Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMBU PA Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations

Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046

Working Losses (lb):	243.2049
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	92,959.0000
Annual Turnovers:	5.7830
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,124.5785

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMBU PA Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	243.20	881.37	1,124.58

APPENDIX D-2

FIELD WIDE ELECTRIFICATION ALTERNATIVE GAS WELL EMISSIONS

Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative C - Gas Wells [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	23.0	8.5	2.0	0.0006	19.2	4.8
	Drilling	577.7	562.5	31.3	1.2	725.4	80.7
	Completion	67.4	22.8	2.6	0.039	384.7	41.1
	Interim Reclamation	0.5	0.5	0.04	0.0004	10.5	1.1
	Wind Erosion	---	---	---	---	5.3	0.8
Wellsite Production Emissions	Production Heaters	483.1	405.8	26.6	2.9	36.7	36.7
	Wellsite Tanks	---	---	1,773.5	---	---	---
	Pneumatics	---	---	306.1	---	---	---
	Fugitives	---	---	1,452.7	---	---	---
	Wellsite Truck Loading	---	---	189.2	---	---	---
	Wellsite Dehydrators	---	---	47.3	---	---	---
	Wellsite Flares	20.1	109.3	---	---	---	---
	Operations Vehicle	7.9	8.0	0.4	0.007	246.2	25.1
Gas Processing Plant Emissions	GP Flares	0.9	4.9	---	---	---	---
	GP Fugitives	---	---	0.8	---	---	---
	GP Dehydrator Heater	0.6	0.5	0.04	0.004	0.05	0.05
	GP Dehydrator	---	---	11.7	---	---	---
Compressor Station Emissions	Compressor Station Tanks	---	---	26.1	---	---	---
	Compressor Station Dehy	---	---	233.8	---	---	---
	Compressor Station Truck Loading and Vehicle Traffic	1.4	0.3	55.7	0.0	31.1	3.2
	Compressor Station Dehydrator Heater	12.9	10.8	0.7	0.1	1.0	1.0
	Compressor Station Flare	17.9	97.2	---	---	---	---
	Compressor Station Fugitives	---	---	60.5	---	---	---
	Electric Substation Gas Turbines	57.1	52.1	19.9	1.1	38.2	38.2
	Total Emissions	**1,270.5**	**1,283.2**	**4,240.9**	**5.3**	**1,498.4**	**232.7**

a Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b]					Total (tons/yr)
	Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	
Criteria Pollutants & VOC						
NO_X	23.0	577.7	67.4	0.5	---	668.6
CO	8.5	562.5	22.8	0.5	---	594.3
VOC	2.0	31.3	2.6	0.04	---	35.9
SO_2	0.0006	1.2	0.04	0.0004	---	1.2
PM_{10}	19.2	725.4	384.7	10.5	5.3	1145.1
$PM_{2.5}$	4.8	80.7	41.1	1.1	0.8	128.4
Hazardous Air Pollutants						
Benzene	---	0.51	0.010	---	---	0.52
Toluene	---	0.18	0.004	---	---	0.19
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.13	0.0026	---	---	0.13
n-Hexane	---	---	---	---	---	---
Formaldehyde	---	0.052	0.0011	---	---	0.053
Acetaldehyde	---	0.017	0.00034	---	---	0.017
Acrolein	---	0.0052	0.00011	---	---	0.0053
Naphthalene	---	0.085	0.0017	---	---	0.087
POM 2	---	0.050	0.0010	---	---	0.051
POM 5	---	0.00040	0.000008	---	---	0.00040
POM 6	---	0.0015	0.000032	---	---	0.0016
POM 7	---	0.0010	0.000021	---	---	0.0010
Greenhouses Gases						
CO_2	569.9	110,750	5,555	49	---	116,923
CH_4	0.0028	4.41	0.18	0.00159	---	4.60
N_2O	0.0010	0.89	0.04	0.00054	---	0.93
CO_2e	570.3	111,118	5,571	49	---	117,308

a Assumes maximum development scenario of 156 wells in one year
b Emissions in summary tables may vary slightly due to rounding differences.
c Total drilling emissions includes Tier IV drill rig engines

Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]								
	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Wellsite Flares	Wellsite Dehydrators	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	483.1	---	---	---	---	20.1	---	7.9	511.1
CO	405.8	---	---	---	---	109.3	---	8.0	523.1
VOC	26.6	1773.5	1452.7	189.2	306.1	---	47.3	0.4	3,795.8
SO_2	2.9	---	---	---	---	---	---	0.007	2.9
PM_{10}	36.7	---	---	---	---	---	---	246.2	283.0
$PM_{2.5}$	36.7	---	---	---	---	---	---	25.1	61.8
Hazardous Air Pollutants									
Benzene	0.010	17.25	3.97	1.84	0.33	---	2.75	---	26.15
Toluene	0.016	28.75	5.20	3.07	0.17	---	11.64	---	48.84
Ethylbenzene	---	1.25	0.20	0.13	---	---	3.41	---	4.99
Xylene	---	10.25	1.69	1.09	0.017	---	24.25	---	37.30
n-Hexane	8.70	45.50	28.85	4.85	5.65	---	---	---	93.56
Formaldehyde	0.36	---	---	---	---	---	---	---	0.36
Dichlorobenzene	0.0058	---	---	---	---	---	---	---	0.0058
Naphthalene	0.0029	---	---	---	---	---	---	---	0.0029
POM 2	0.00029	---	---	---	---	---	---	---	0.00029
POM 3	0.000077	---	---	---	---	---	---	---	0.000077
POM 4	0.0000087	---	---	---	---	---	---	---	0.0000087
POM 5	0.000012	---	---	---	---	---	---	---	0.000012
POM 6	0.000035	---	---	---	---	---	---	---	0.000035
POM 7	0.0000087	---	---	---	---	---	---	---	0.000009
Greenhouse Gases									
CO_2	575,965.1	358.3	33.9	38.2	9.5	24,974.9	---	746.9	602,127
CH_4	10.86	1698.3	3871.0	181.19	1,079.17	238.0	73.98	0.0173	7,152
N_2O	1.09	---	---	---	---	0.0	---	0.0045	1.13
CO_2e	576,530	36,022	81,324	3,843	22,672	29,986	1,553	749	752,679

a Assumes maximum development scenario of 2500 gas wells

b Emissions in summary tables may vary slightly due to rounding differences.

Total Project Infrastructure Related Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]								
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Central Facility Flares	Dehydrators	Substation Turbines	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	13.5	---	---	---	18.8	---	57.1	1.4	90.8
CO	11.4	---	---	---	102.1	---	52.1	0.3	165.9
VOC	0.7	26.1	61.4	55.6	---	245.5	19.9	0.04	409.2
SO_2	0.08	---	---	---	---	---	1.1	0.001	1.2
PM_{10}	1.0	---	---	---	---	---	38.2	31.1	70.3
$PM_{2.5}$	1.0	---	---	---	---	---	38.2	3.2	42.4
Hazardous Air Pollutants									
Benzene	0.00028	0.254	0.125	0.54	---	11.76	0.083	---	12.76
Toluene	0.00046	0.423	0.142	0.90	---	8.27	0.90	---	10.63
Ethylbenzene	---	0.0184	0.0049	0.0392	---	---	0.22	---	0.28
Xylene	---	0.151	0.043	0.322	---	1.48	0.44	---	2.44
n-Hexane	0.24	0.67	1.18	1.43	---	7.13	---	---	10.65
Formaldehyde	0.010	---	---	---	---	---	4.90	---	4.91
Acetaldehyde	---	---	---	---	---	---	0.28	---	0.28
Acrolein	---	---	---	---	---	---	0.044	---	0.044
Methanol	---	---	---	---	---	---	---	---	---
1,1,2,2-Tetrachloroethane	---	---	---	---	---	---	---	---	---
1,1,2-Trichloroethane	---	---	---	---	---	---	---	---	---
1,3-Dichloropropene	---	---	---	---	---	---	---	---	---
1,3-Butadiene	---	---	---	---	---	---	0.0030	---	0.0030
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	---	---
Biphenyl	---	---	---	---	---	---	---	---	---
Carbon Tetrachloride	---	---	---	---	---	---	---	---	---
Chlorobenzene	---	---	---	---	---	---	---	---	---
Chloroform	---	---	---	---	---	---	---	---	---
Dichlorobenzene	0.00016	---	---	---	---	---	---	---	0.00016
Ethylene Dibromide	---	---	---	---	---	---	---	---	---
Methylene Chloride	---	---	---	---	---	---	---	---	---
Naphthalene	0.000083	---	---	---	---	---	0.0090	---	0.0091
Phenol	---	---	---	---	---	---	---	---	---
Propylene Oxide	---	---	---	---	---	---	0.20	---	0.20
Styrene	---	---	---	---	---	---	---	---	---
Tetrachloroethane	---	---	---	---	---	---	---	---	---
Vinyl Chloride	---	---	---	---	---	---	---	---	---
PAH -POM 1	---	---	---	---	---	---	0.015	---	0.015
POM 2	0.0000080	---	---	---	---	---	---	---	0.000008
POM 3	0.0000022	---	---	---	---	---	---	---	0.000002
POM 4	0.00000024	---	---	---	---	---	---	---	0.0000002
POM 5	0.00000032	---	---	---	---	---	---	---	0.0000003
POM 6	0.00000097	---	---	---	---	---	---	---	0.0000010
POM 7	0.00000024	---	---	---	---	---	---	---	0.0000002
Greenhouse Gases									
CO_2	16,127	105.3	1.61	11.24	36,935	---	930,560	116	983,856
CH_4	0.30	25.0	183.9	53.27	352.0	301.38	17.6	0.00066	933.3
N_2O	0.030	---	---	---	0.062	---	1.8	0.00010	1.8
CO_2e	16,143	630	3,864	1,130	44,345	6,329	931,472	116	1,004,029

a Assumes maximum development scenario of 2500 gas wells
b Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	668.6	511.1	90.8	1,270.5
CO	594.3	523.1	165.9	1,283.2
VOC	35.9	3,795.8	409.2	4,240.9
SO_2	1.2	2.9	1.2	5.3
PM_{10}	1,145.1	283.0	70.3	1,498.4
$PM_{2.5}$	128.4	61.8	42.4	232.7
Hazardous Air Pollutants				
Benzene	0.519	26.15	12.76	39.43
Toluene	0.188	48.84	10.63	59.66
Ethylbenzene	---	4.99	0.28	5.28
Xylene	0.1290	37.30	2.44	39.86
n-Hexane	---	93.56	10.65	104.21
Formaldehyde	0.0527	0.36	4.91	5.32
Acetaldehyde	0.0168	---	0.28	0.29
Acrolein	0.00527	---	0.044	0.049
Methanol	---	---	---	---
1,1,2,2-Tetrachloroethane	---	---	---	---
1,1,2-Trichloroethane	---	---	---	---
1,3-Dichloropropene	---	---	---	---
1,3-Butadiene	---	---	0.0030	0.0030
2,2,4-Trimethylpentane	---	---	---	---
Biphenyl	---	---	---	---
Carbon Tetrachloride	---	---	---	---
Chlorobenzene	---	---	---	---
Chloroform	---	---	---	---
Dichlorobenzene	---	0.0058	0.00016	0.0060
Ethylene Dibromide	---	---	---	---
Methylene Chloride	---	---	---	---
Naphthalene	0.0869	0.0029	0.0091	0.10
Phenol	---	---	---	---
Propylene Oxide	---	---	0.20	0.20
Styrene	---	---	---	---
Tetrachloroethane	---	---	---	---
Vinyl Chloride	---	---	---	---
(PAH) POM 1	---	---	0.015	0.015
POM 2	0.0515	0.00029	0.000008	0.052
POM 3	---	0.000077	0.0000022	0.000079
POM 4	---	0.0000087	0.0000002	0.000009
POM 5	0.000403	0.000012	0.0000003	0.00042
POM 6	0.001580	0.000035	0.0000010	0.0016
POM 7	0.001023	0.000009	0.0000002	0.0010
Total HAPs	1.05	211.21	42.23	254.48
Greenhouse Gases				
CO_2	116,923	602,127	983,856	1,702,905
CH_4	4.60	7,152	933	8,090
N_2O	0.93	1.13	1.85	3.91
CO_2e	117,308	752,679	1,004,029	1,874,015

a Emissions for Peak Field Development

b Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	3	days per well pad
	12	hours per day
	36	hours per well pad
Annual amount of well pads	156	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = 5.7 * (soil silt content %)$^{1.2}$ * (soil moisture content %)$^{-1.3}$* Control Efficiency

Emissions (PM_{15} lbs/hr) = 1.0 * (soil silt content %)$^{1.5}$ * (soil moisture content %)$^{-1.4}$ * Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.035	5.53	1.97	0.035	5.53	11.07
PM_{15}	0.50	0.009	1.41	0.50	0.009	1.41	2.82
PM_{10}	0.38	0.007	1.06	0.38	0.007	1.06	2.11
$PM_{2.5}$	0.21	0.00372	0.58	0.21	0.004	0.58	1.16

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	3	day grading per well pad
	12	hours/day
	36	hours per well pad
Deep gas well pads	156	well pads/year
Oil well pads	0	well pads/year
Distance graded - Deep gas well	1.96	miles
Distance graded - Oil well	0.00	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Deep gas wells			Total Emissions
	lbs/well	lbs/hr/well pad	tons/well pad	tons/year[a]
TSP	5.27	0.15	0.0026	0.41
PM_{15}	2.52	0.07	0.0013	0.20
PM_{10}	1.51	0.042	0.00076	0.12
$PM_{2.5}$	0.16	0.005	0.000082	0.013

a Assumes maximum development scenario

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Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

3. Road Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	4	days per mile
	12	hours per day
	0.19	miles of road per well pad
	9	hours per well pad road
Annual amount of well pads with roads	156	pads with roads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content }\%)^{1.2} * (\text{soil moisture content }\%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.009	1.38	1.97	0.009	1.38	2.75
PM_{15}	0.50	0.002	0.35	0.50	0.002	0.35	0.70
PM_{10}	0.38	0.002	0.26	0.38	0.002	0.26	0.53
$PM_{2.5}$	0.21	0.0009	0.14	0.21	0.001	0.14	0.29

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

4. Road Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	9	hours per well pad roads
Road construction grading distance	0.37	miles road per well pad
Annual well pads	156	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Roads			Total Emissions
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	1.00	0.11	0.0005	0.08
PM_{15}	0.48	0.05	0.00024	0.037
PM_{10}	0.29	0.032	0.00014	0.022
$PM_{2.5}$	0.03	0.003	0.000016	0.0024

a Assumes maximum development scenario

5. Pipeline Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	10	days per mile
	12	hours per day
	0.19	miles of pipeline per well pad
	22	hours per well pad pipeline
Annual amount of well pads withpipeline	156	pads with pipeline/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content }\%)^{1.2} * (\text{soil moisture content }\%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.022	3.44	1.97	0.022	3.44	6.88
PM_{15}	0.50	0.006	0.88	0.50	0.006	0.88	1.75
PM_{10}	0.38	0.0042	0.66	0.38	0.0042	0.66	1.31
$PM_{2.5}$	0.21	0.0023	0.36	0.21	0.0023	0.36	0.72

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

6. Pipeline Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	22	hours per well pad pipeline
Pipeline construction grading distance	0.75	miles pipeline per well pad
Annual well pads	156	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Pipeline			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	2.00	0.09	0.0010	0.16
PM_{15}	0.96	0.043	0.00048	0.07
PM_{10}	0.58	0.026	0.00029	0.04
$PM_{2.5}$	0.06	0.0028	0.000031	0.005

a Assumes maximum development scenario

7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual
$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual
$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily
$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S) 5.1 AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles 19
Precipitation Days (P) 45 days per year (NCDC data for Ouray, UT 1955-2004)
W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily
$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles 6
Precipitation Days (P) 45 days per year
W = average weight in tons of vehicles traveling the road

Construction Emissions

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of pads per year	156	well pads/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	1.20	1.05	5.61	0.09	13.81
$PM_{2.5}$	0.12	0.11	0.56	0.009	1.38

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	0.015	0.014	0.023	0.00040	0.06
$PM_{2.5}$	0.0036	0.0035	0.006	0.00010	0.015

Drilling - Deep Gas Wells

Hours per day	24	hour/day
Days per deep gas well	55	day/well
Number of wells per year	156	wells /year

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	30,857	---
Total Round Trips	---	7

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	1.45	1.27	7.90	4.57	712.87
$PM_{2.5}$	0.15	0.13	0.79	0.46	71.29

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	0.023	0.022	0.041	0.0261	4.06
$PM_{2.5}$	0.0055	0.0054	0.010	0.0064	1.00

Project: GMBU - Alternative C -Gas Wells

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7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S) 5.1 AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles 19
Precipitation Days (P) 45 days per year (NCDC data for Ouray, UT 1955-2004)
W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles 6
Precipitation Days (P) 45 days per year
W = average weight in tons of vehicles traveling the road

Interim Reclamation

Hours per day	12	hour/day
Days per pad	3	day/well pad
Number of wells per year	156	wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	1.35	1.19	4.21	0.07	10.37
$PM_{2.5}$	0.14	0.12	0.42	0.007	1.04

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	0.019	0.019	0.020	0.00035	0.05
$PM_{2.5}$	0.0047	0.0046	0.005	0.00009	0.013

Completion - Deep Gas Well

Hours per day	24	hour/day
Days per deep gas well	24	day/well
Number of wells per year	156	wells /year

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	4
Haul Trucks	45,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	35,750	---
Total Round Trips	---	8

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	1.55	1.36	9.64	2.43	379.85
$PM_{2.5}$	0.16	0.14	0.96	0.24	37.98

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	0.026	0.025	0.05	0.02	2.36
$PM_{2.5}$	0.006	0.006	0.01	0.004	0.58

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	**Paved Total tons/year**	**Total tons/year**
PM_{10}	1116.90	6.54	1123.44
$PM_{2.5}$	111.69	1.60	113.29

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

8. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	377	acres total disturbance for roads and pipelines per year
	1,523,892	square meters total initial disturbance for roads and pipelines
	468	acres total disturbance for well pads per year
	1,893,926	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed ($U_{10}^{+)}$)	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\ U_{10}^+$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, P = 0 for $U^*< U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	<10 µm	<2.5 µm
1.0	0.5	0.075

Maxium U_{10}^+ Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2-period	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2-period
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	10.68	0.00
PM_{10}	5.34	0.00
$PM_{2.5}$	0.80	0.00

9. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction	3	days per well pad
Well pads per year	156	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.031	0.00055	0.18	0.52
CO	1.98E-02	0.041	0.00074	7.26E-02	0.30	0.0054	0.34	0.96
VOC	3.16E-03	0.0065	0.00012	3.54E-03	0.015	0.00026	0.021	0.060
SO_2	4.57E-05	0.000095	0.0000017	2.83E-05	0.00012	0.0000021	0.00021	0.00060
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00080	0.000014	0.010	0.027
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00074	0.000013	0.0092	0.026
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	6.67	0.12	20.61	57.88
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00086	0.000016	0.0010	0.0028
N_2O	1.20E-05	0.000025	0.00000045	8.05E-05	0.00033	0.0000060	0.00036	0.0010
CO_2e [d]	---	13.95	0.25	---	6.79	0.12	20.75	58.25

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	156	new pads per year
Backhoe miles per pad	0.77	miles (Value assumed to be 1/4 of dozer or grader mileage)
Backhoe Hours	67.3	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer miles per pad	3.1	miles
Dozer Hours	67.3	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader miles per pad	3.1	miles
Motor Grader Hours	67.3	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horse Power} * \text{Hours} * \text{Load Factor}}{453.6\text{ (g/lb)} * 2000\text{ (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)
Criteria Pollutants & VOC									
NOx	6.9	0.28	0.0094	8.38	1.48	0.050	8.38	2.52	0.085
CO	3.49	0.14	0.0047	2.7	0.48	0.016	2.70	0.81	0.027
VOC [b]	0.99	0.040	0.0013	0.68	0.12	0.0041	0.68	0.20	0.0069
PM_{10}	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
$PM_{2.5}$	0.722	0.029	0.0010	0.402	0.071	0.0024	0.402	0.12	0.0041
Greenhouse Gases									
CO_2 [c]	188.2	7.59	0.26	188.2	33.31	1.12	188.2	56.59	1.91
CO_2e [e]	---	7.59	0.26	---	33.31	1.12	---	56.59	1.91

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC		
NOx	4.28	22.49
CO	1.43	7.51
VOC	0.36	1.92
PM_{10}	0.22	1.16
$PM_{2.5}$	0.22	1.16
Greenhouse Gases		
CO_2	97.50	512.02
CO_2e [e]	97.50	512.02

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor:	73.96	kg CO_2/mmBtu
	393	hp-hr = mmBtu
	188.2	g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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11. Drilling Tailpipe Emissions

Assumptions:

Number of deep gas wells drilled	156	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	1320	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	5	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{2000 \text{ (lb/ton)}}$$

Drilling Vehicles	**Heavy Haul Trucks-Deep Gas Wells**			**Heavy Duty Pickups-Deep Gas Wells**			**Total-Deep Gas Wells**[c]	
	E. Factor [a]	Emissions	Emissions	E. Factor [b]	Emissions	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/hr)	(tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.39	0.25	7.39E-03	0.015	0.0101	0.40	41.25
CO	1.98E-02	0.10	0.068	7.26E-02	0.15	0.0993	0.25	26.04
VOC [c]	3.16E-03	0.016	0.011	3.54E-03	0.0073	0.0048	0.024	2.44
SO_2	4.57E-05	0.00024	0.00016	2.83E-05	0.000059	0.0000	0.00030	0.030
PM_{10}	4.22E-03	0.022	0.014	1.94E-04	0.00040	0.0003	0.022	2.29
$PM_{2.5}$	4.09E-03	0.021	0.014	1.79E-04	0.00037	0.0002	0.022	2.22
Greenhouse Gases								
CO_2	6.73E+00	34.86	23.00	1.61E+00	3.34	2.2014	38.19	3932.16
CH_4	6.56E-05	0.00034	0.00022	2.08E-04	0.00043	0.0003	0.00077	0.079
N_2O	1.20E-05	0.000062	0.000041	8.05E-05	0.00017	0.0001	0.00023	0.024
CO_2e [d]	---	34.88	23.02	---	3.40	2.24	38.28	3941.14

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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12. Completion Tailpipe Emissions

Assumptions:

Number of deep gas wells	156	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks-Deep Gas Wells			Heavy Duty Pickups-Deep Gas Wells			Total-Deep Gas Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.13	7.39E-03	0.015	0.004	0.48	21.46
CO	1.98E-02	0.12	0.04	7.26E-02	0.15	0.04	0.27	12.29
VOC [c]	3.16E-03	0.020	0.006	3.54E-03	0.007	0.0021	0.03	1.21
SO_2	4.57E-05	0.0003	0.00008	2.83E-05	0.00006	0.000017	0.0003	0.015
PM_{10}	4.22E-03	0.03	0.008	1.94E-04	0.0004	0.00012	0.03	1.20
$PM_{2.5}$	4.09E-03	0.03	0.007	1.79E-04	0.0004	0.00011	0.03	1.16
Greenhouse Gases								
CO_2	6.73E+00	41.83	12.05	1.61E+00	3.34	0.96	45.16	2029.05
CH_4	6.56E-05	0.0004	0.00012	2.08E-04	0.0004	0.00012	0.0008	0.04
N_2O	1.20E-05	0.00007	0.00002	8.05E-05	0.00017	0.00005	0.00024	0.011
CO_2e [d]	---	41.86	12.06	---	3.40	0.98	45.25	2033

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

13. Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	156	
Average Round Trip Distance	24.9	miles
Hours of Operation	36	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/well) * Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0028	7.39E-03	0.015	0.00028	0.169	0.48
CO	1.98E-02	0.041	0.00074	7.26E-02	0.15	0.0027	0.19	0.54
VOC [c]	3.16E-03	0.0065	0.00012	3.54E-03	0.0073	0.00013	0.014	0.039
SO_2	4.57E-05	0.00009	0.0000017	2.83E-05	0.000059	0.0000011	0.00015	0.00043
PM_{10}	4.22E-03	0.0087	0.00016	1.94E-04	0.00040	0.0000072	0.0091	0.026
$PM_{2.5}$	4.09E-03	0.0085	0.00015	1.79E-04	0.00037	0.0000067	0.0088	0.025
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.25	1.61E+00	3.34	0.060	17.28	48.52
CH_4	6.56E-05	0.00014	0.0000024	2.08E-04	0.00043	0.0000078	0.00057	0.0016
N_2O	1.20E-05	0.00002	0.0000004	8.05E-05	0.00017	0.0000030	0.00019	0.00054
CO_2e [d]	---	13.95	0.25	---	3.40	0.061	17.35	48.72

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Project: GMBU - Alternative C -Gas Wells

Date: 7/15/2013

14. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation	1320	hours/deep gas well
Development Rate	156	deep gas wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

$$\text{Emissions (ton/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{horsepower (hp)} * \text{Hours (hour/year)} * \text{Load factor}}{\text{2000 lb/ton}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 , 10/96

Drill Rig Emissions (Tier 4)

Species	Drill Rig E. Factor (lb/hp-hr)	Drill Rig Emissions (lb/hr)	Gas Well Drill Rig Emissions (tons/yr-well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC				
NOx [a]	5.73E-03	5.21	3.44	536.44
CO [a]	5.73E-03	5.21	3.44	536.44
VOC [a]	3.09E-04	0.28	0.19	28.89
PM_{10} [a]	6.61E-05	0.06	0.04	6.19
$PM_{2.5}$ [a]	6.61E-05	0.06	0.04	6.19
SO_2 [b]	1.21E-05	0.011	0.0073	1.14
Hazardous Air Pollutants				
Benzene [c]	5.43E-06	0.0049	0.0033	0.51
Toluene [c]	1.97E-06	0.0018	0.0012	0.18
Xylenes [c]	1.35E-06	0.0012	0.00081	0.13
Formaldehyde [c]	5.52E-07	0.00050	0.00033	0.052
Acetaldehyde [c]	1.76E-07	0.00016	0.00011	0.017
Acrolein [c]	5.52E-08	0.00005	0.000033	0.0052
Naphthalene [d]	9.10E-07	0.00083	0.00055	0.085
POM 2 [d,e,f]	5.39E-07	0.00049	0.00032	0.050
POM 5 [d,e,g]	4.22E-09	0.0000038	0.0000025	0.00040
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000099	0.0015
POM 7 [d,e,i]	1.07E-08	0.000010	0.0000064	0.0010
Greenhouse Gases				
CO_2 [j]	1.14	1037.47	684.73	106,818
CH_4 [j,k]	4.63E-05	0.042	0.028	4.33
N_2O [j,k]	9.26E-06	0.0084	0.0056	0.87
CO_2e [m]	---	1040.96	687.03	107,177

a Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM) Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr

d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

i POM 7 includes: Chrysene.

j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

l Assumes maximum development scenario

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

15. Well Fracturing Engine

Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Typical frac engine horsepower	660	hp (deep gas wells)
Frac engine load factor	0.62	
Hours per frac job	60	hours/well (deep gas wells)
Development Rate - Deep Gas Wells	156	wells/year (deep gas wells)

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

Emissions (tons/year) = $\frac{\text{Emission Factor (lb/hp-hr) * Horsepower (hp)* Hours (hour/year) * Load Factor}}{\text{2000 lb/ton}}$

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

Species	Frac Engine Emissions				
	E. Factor (lb/MMBtu)	E. Factor (lb/hp-hr)	Gas Well Emissions (lb/hr)	Gas Well Emissions (tons/yr-well)	Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	3.2	0.024	9.82	0.29	45.96
CO [a]	0.85	5.50E-03	2.25	0.07	10.53
VOC [a]	0.09	7.05E-04	0.29	0.009	1.35
PM_{10} [a]	0.10	0.0007	0.29	0.009	1.34
$PM_{2.5}$ [a]	0.10	0.0007	0.29	0.009	1.34
SO_2 [a]	1.52E-03	1.21E-05	0.0050	0.00015	0.023
Hazardous Air Pollutants					
Benzene [b]	7.76E-04	5.43E-06	0.0022	0.000067	0.010
Toluene [b]	2.81E-04	1.97E-06	0.00080	0.000024	0.0038
Xylenes [b]	1.93E-04	1.35E-06	0.00055	0.000017	0.0026
Formaldehyde [b]	7.89E-05	5.52E-07	0.00023	0.0000068	0.0011
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000072	0.0000022	0.00034
Acrolein [b]	7.88E-06	5.52E-08	0.000023	0.00000068	0.00011
Naphthalene [c]	1.30E-04	9.10E-07	0.00037	0.000011	0.0017
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00022	0.0000066	0.0010
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000017	0.000000052	0.000008
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000068	0.00000020	0.000032
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000044	0.00000013	0.000021
Greenhouse Gases					
CO_2 [i]	163.05	1.14	753.3	22.60	3525.4
CH_4 [j]	6.61E-03	4.63E-05	0.031	0.00092	0.14
N_2O [j]	1.32E-03	9.26E-06	0.0061	0.00018	0.029
CO_2e [l]	---	---	755.8	22.7	3,537.3

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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16. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction:	0.794
VOC Wt. Fraction:	0.191
Non-HC Wt. Fraction:	0.015
Total:	1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

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17. Operations Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	261,747	miles/year-all wells
Operation Pickup Truck Mileage:	295,888	miles/year-all wells
Hours of Operation:	10	hours per day
Hours of Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total [d]**	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	3.84	7.01	6.05E-03	0.49	0.90	4.33	7.91
CO	1.02E-02	0.73	1.33	4.48E-02	3.63	6.63	4.36	7.96
VOC [c]	1.55E-03	0.11	0.20	1.61E-03	0.13	0.24	0.24	0.44
SO_2	3.07E-05	0.002	0.004	1.84E-05	0.0015	0.0027	0.004	0.007
PM_{10}	2.57E-03	0.18	0.34	1.31E-04	0.011	0.019	0.19	0.36
$PM_{2.5}$	2.50E-03	0.18	0.33	1.21E-04	0.010	0.018	0.19	0.35
Greenhouse Gases								
CO_2	4.520	324.1	591.5	1.050	85.1	155.3	409.3	746.9
CH_4	2.59E-05	0.0019	0.003	9.38E-05	0.008	0.014	0.009	0.017
N_2O	4.01E-06	0.0003	0.0005	2.68E-05	0.0022	0.0040	0.0025	0.004
CO_2e [c]	---	324.3	591.8	---	86.0	156.9	410.2	748.6

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

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18. Operations Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily E (PM_{10}) / VMT = $1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily E $(PM_{2.5})$ / VMT = $0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual E (PM_{10}) / VMT = $1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365\text{-}p)/365)$

Annual E $(PM_{2.5})$ / VMT = $0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365\text{-}p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily E (PM_{10}) / VMT = $0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily E $(PM_{2.5})$ / VMT = $0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual E (PM_{10}) / VMT = $0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual E $(PM_{2.5})$ / VMT = $0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of producing wells	2500	wells

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.33	1.17	0.061	0.098	244.60
$PM_{2.5}$	0.13	0.12	0.0061	0.0098	24.46

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	29
Light Trucks	8,000	33
Mean Vehicle Weight	25,416	---
Total Round Trips	---	62

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.018	0.018	0.00028	0.00052	1.29
$PM_{2.5}$	0.0045	0.0045	0.000069	0.000126	0.32

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

19. Gas Well Storage Tanks Working, Breathing, and Flashing Emissions

Assumptions:

Gas well production rate	2.0	barrels/day-well
Total Gas Wells	2500	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:
Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	**Tank Emissions (tons/yr-tank)**	**Controlled Tank Emissions (tons/yr-tank)**	**Total Wellsite Emissions [a] (tons/yr)**
VOC	0.71	0.00	1773.50
Hazardous Air Pollutants			
Benzene	0.0069	0.00	17.25
Toluene	0.012	0.00	28.75
Ethylbenzene	0.00050	0.00	1.25
Xylenes	0.0041	0.00	10.25
n-Hexane	0.018	0.00	45.50
Greenhouse Gases			
CO_2	0.14	0.00	358.3
CH_4	0.68	0.00	1698.3
CO_2e	14	0.00	36,022

a Total wellsite flashing emissions are based on 2500 uncontrolled tanks and 0 tanks controlled at 0%.

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20. Condensate Truck Loadout

Assumptions:

Deep Gas Well Condensate Production Rate	2.0	bbl/day-well
Number of Deep Gas Wells	2500	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (ºR)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [b]
Condensate Loading [a]	0.6	5.2	66	520	4.94	2.0	0.076	189.22

	Condensate Loading tpy-well [c]	Condensate Loading tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.00074	1.84
Toluene	0.0012	3.07
Ethylbenzene	0.000053	0.13
Xylenes	0.00044	1.09
n-Hexane	0.0019	4.85
Greenhouse Gases		
CO_2	0.015	38.22
CH_4	0.072	181.19
CO_2e	1.54	3843.3

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60^{o}F.
b Assumes maximum development scenario
c Emissions estimated based on ratio of HAP/VOC in tank emissions

21. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.0546	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.0008	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.00520	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.00230	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.320

Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
2,500	306.08	1,079.17	9.45	22,672

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

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22. Production Heater Emissions

Assumptions

Deep Gas Well Dehydrator Heater Size	750	Mbtu/hr
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Gas wells with dehydrators	2500	wells
Load Factor	0.6	load rate

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Deep Gas Well Dehydrator Heater			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	100	0.044	0.19	110.29	483.09
CO [a]	84	0.037	0.16	92.65	405.79
VOC [b]	5.5	0.0024	0.011	6.07	26.57
SO_2 [b]	0.6	0.00026	0.0012	0.66	2.90
PM_{10} [b]	7.6	0.0034	0.015	8.38	36.71
$PM_{2.5}$ [b]	7.6	0.0034	0.015	8.38	36.71
Hazardous Air Pollutants					
Benzene [c]	2.10E-03	9.26E-07	4.06E-06	0.0023	0.010
Toluene [c]	3.40E-03	1.50E-06	6.57E-06	0.0038	0.016
Hexane [c]	1.80E+00	7.94E-04	3.48E-03	1.99	8.70
Formaldehyde [c]	7.50E-02	3.31E-05	1.45E-04	0.083	0.36
Dichlorobenzene [c]	1.20E-03	5.29E-07	2.32E-06	0.0013	0.0058
Naphthalene [c]	6.10E-04	2.69E-07	1.18E-06	0.00067	0.0029
POM 2[c,d,e]	5.90E-05	2.60E-08	1.14E-07	0.000065	0.00029
POM 3[c,f]	1.60E-05	7.06E-09	3.09E-08	0.000018	0.00008
POM 4[c,g]	1.80E-06	7.94E-10	3.48E-09	0.000002	0.00001
POM 5[c,h]	2.40E-06	1.06E-09	4.64E-09	0.000003	0.00001
POM 6[c,i]	7.20E-06	3.18E-09	1.39E-08	0.000008	0.00003
POM 7[c,j]	1.8E-06	7.94E-10	3.48E-09	0.000002	0.00001
Greenhouse Gases					
CO_2 [l]	119,226	52.60	230.39	131,499	575,965
CH_4 [l]	2.25	0.0010	0.0043	2.48	10.86
N_2O [l]	0.22	0.00010	0.00043	0.25	1.09
CO_2e [m]	---	52.65	230.61	131,628	576,530

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

23. Deep Gas Well Fugitive Emissions

Number of Producting Wells 2500 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.35
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.08
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.056
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.027
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.015
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.049
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	----
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
VOC EMISSIONS (tons/yr-well)						0.58
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**1452.70**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B

b Weight fractions from wellsite gas analysis and estimates

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction[b]	Liquid Weight Fraction of VOCs[b]	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	3.97
Toluene Emissions	0.0001	0.0162	5.20
Ethylbenzene Emissions	----	0.0007	0.20
Xylene Emissions	0.00001	0.0058	1.69
n-Hexane Emissions	0.0035	0.0257	28.85

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	49	8,760	0.84	0.0027	0.121	0.92	0.0081	19.36
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.0041	9.83
Open-Ended Lines - Gas	4	8,760	0.84	0.0027	0.031	0.019	0.00017	0.40
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						1.55	0.0135	32.53
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**3870.96**	**33.87**	**81324**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

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24. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.4 MMscf/day/well
Wells Requiring Dehydrators: 2,500 wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95 % Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
VOC	0.0043	0.019	47.28
Hazardous Air Pollutants			
Benzene	0.00025	0.0011	2.75
Toluene	0.0011	0.0047	11.64
Ethylbenzene	0.00031	0.0014	3.41
Xylenes	0.0022	0.010	24.25
Greenhouse Gases			
CH_4	0.0068	0.030	73.98
CO_2e	0.14	0.62	1553.48

25. Wellsite Flare Emissions

Assumptions:

Number of gas well dehydrators with controls	2500	well pads
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [c] (lb/hr)	Total Emissions [c] (tons/yr)
Criteria Pollutants					
NO_x [a]	0.068	0.002	0.01	4.59	20.09
CO [a]	0.37	0.01	0.04	24.96	109.31
Greenhouse Gases					
CO_2 [b]	---	2.28	9.99	5,702	24,975
CH_4 [b]	---	0.02	0.10	54.3	238.0
N_2O [b]	---	0.00000	0.00002	0.0	0.042
CO_2e [b]	---	2.74	11.99	6,846	29,986

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

26. Compressor Station Condensate Tanks

Assumptions:

Average Condensate Production Rate :		
Facility Production Rate	73.5	bbls per day per facility
Tank Control Efficiency	95	%
Total Facilities	20	Compressor Stations
Number of Tanks at Comp Station	4	tanks/facility

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS
Controlled by combustion device with 95% efficiency

Component	Tank Emissions (tons/yr/Tank)	Controlled Tank Emissions (tons/yr/Tank)	Total[a] Emissions (tons/yr)
Total VOC	6.52	0.33	26.07
Hazardous Air Pollutants			
Benzene	0.063	0.0032	0.254
Toluene	0.11	0.0053	0.423
Ethylbenzene	0.0046	0.00023	0.0184
Xylenes	0.038	0.0019	0.151
n-Hexane	0.17	0.0084	0.67
Greenhouse Gases			
CO_2	1.32	1.32	105.33
CH_4	6.24	0.31	24.96
CO_2e	132	7.87	629.6

a Assumes maximum development scenario

27. Compressor Station Dehydrator Emissions

Assumptions

Number of Compressor Stations 20 Stations
Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69	233.83
Hazardous Air Pollutants			
Benzene	0.13	0.56	11.20
Toluene	0.090	0.39	7.88
Ethylbenzene	---	---	---
Xylenes	0.016	0.070	1.41
n-Hexane	0.078	0.34	6.79
Greenhouse Gases			
CH_4	3.28	14.35	287.02
CO_2e	68.81	301.38	6027.50

a Assumes maximum development scenario

28. Compressor Station Fugitive Emissions

Number of Compressor Stations 20 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	114	8,760	0.19	4.50E-03	9.95E-03	0.95
Valves - Light Oil	28	8,760	0.41	2.50E-03	5.53E-03	0.28
Valves - Heavy Oil	0	8,760	0.41	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	28	8,760	0.41	9.80E-05	2.17E-04	0.011
Connectors - Gas	520	8,760	0.19	2.00E-04	4.42E-04	0.19
Connectors - Light Oil	44	8,760	0.41	2.10E-04	4.64E-04	0.04
Connectors - Heavy Oil	0	8,760	0.41	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	45	8,760	0.41	1.10E-04	2.43E-04	0.020
Open-Ended Lines - Gas	2	8,760	0.19	2.00E-03	4.42E-03	0.0074
Open-Ended Lines - Light Oil	0	8,760	0.41	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.41	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.41	2.50E-04	5.53E-04	---
Flanges - Gas	72	8,760	0.19	3.90E-04	8.62E-04	0.052
Flanges - Light Oil	0	8,760	0.41	1.10E-04	2.43E-04	---
Flanges - Heavy Oil	0	8,760	0.41	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	0	8,760	0.41	2.90E-06	6.41E-06	---
Other - Gas	91	8,760	0.19	8.80E-03	1.94E-02	1.48
Other - Light Oil	0	8,760	0.41	7.50E-03	1.66E-02	---
Other - Heavy Oil	0	8,760	0.41	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	0	8,760	0.41	1.40E-02	3.09E-02	---
Compressor station VOC Emissions (tons/yr)						**3.03**
Total Compressor station VOC Emissions (tons/yr)[d]						**60.55**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{2000 \text{ (lb/ton)}}$$

a Number of components referenced from similar existing facilities

b VOC and HAP weight fractions from wellsite gas analysis and compressor tank emissions

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Liquid Weight Fraction of VOCs	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.124
Toluene Emissions	0.0001	0.016	0.141
Ethylbenzene Emissions	----	0.00070	0.005
Xylene Emissions	0.00001	0.0058	0.043
n-Hexane Emissions	0.0035	0.026	1.17

28. Compressor Station Fugitive Emissions

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	170	8,760	0.84	0.0027	0.121	3.20	0.028	67.17
Connectors - Gas	609	8,760	0.84	0.0027	0.017	1.61	0.014	33.81
Open-Ended Lines - Gas	2	8,760	0.84	0.0027	0.031	0.010	0.000084	0.20
Flanges - Light Oil	72	8,760	0.84	0.0027	0.003	0.034	0.00029	0.71
Other - Light Oil	91	8,760	0.84	0.0027	0.3	4.24	0.037	89.14
Compressor station GHG Emissions (tons/yr)						**9.09**	**0.080**	**191.0**
Total Compressor station GHG Emissions (tons/yr)[d]						**181.85**	**1.591**	**3820.5**

a Number of components referenced from similar existing facilities

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

29. Compressor Station Truck Loadout

Assumptions:		
Facility Production Rate	74	bbls per day per facility
Total Facilities	20	

AP - 42, Chapter 5.2

$L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility	tpy[b]
12.46	0.6	5.2	66	520	4.94	74	2.78	55.63

	tpy-facility[c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.027	0.54
Toluene	0.045	0.90
Ethylbenzene	0.0020	0.039
Xylenes	0.016	0.32
n-Hexane	0.071	1.43
Greenhouse Gases		
CO2	0.56	11.24
CH4	2.664	53.27
CO2e	56.50	1129.92

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60^o F.

b Emission for full buildout

c Emissions estimated based on condensate tank analysis

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30. Compressor Station Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	51,302	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{2000 \text{ (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.75	1.37	6.05E-03	0.00	0.00	0.75	1.37
CO	1.02E-02	0.14	0.26	4.48E-02	0.00	0.00	0.14	0.26
VOC [c]	1.55E-03	0.022	0.040	1.61E-03	0.00	0.00	0.022	0.040
SO_2	3.07E-05	0.0004	0.001	1.84E-05	0.00	0.00	0.0004	0.0008
PM_{10}	2.57E-03	0.036	0.066	1.31E-04	0.00	0.00	0.036	0.066
$PM_{2.5}$	2.50E-03	0.035	0.064	1.21E-04	0.00	0.00	0.035	0.064
Greenhouse Gases								
CO_2	4.520	63.5	115.9	1.050	0.0	0.0	63.5	115.9
CH_4	2.59E-05	0.0004	0.001	9.38E-05	0.00	0.00	0.0004	0.001
N_2O	4.01E-06	0.0001	0.0001	2.68E-05	0.00	0.00	0.0001	0.0001
CO_2e [c]	---	63.6	116.0	---	0.0	0.0	63.6	116.0

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

31. Compressor Station Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of Compressor Stations	20	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	6
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	6

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	0.96	1.54	30.80
$PM_{2.5}$	0.17	0.15	0.096	0.15	3.08

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.0062	0.0112	0.22
$PM_{2.5}$	0.0081	0.0081	0.0015	0.0028	0.055

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

32. Gas Processing Plant Dehydrator Emissions

Assumptions

Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69
Hazardous Air Pollutants		
Benzene	0.13	0.56
Toluene	0.090	0.39
Ethylbenzene	---	---
Xylenes	0.016	0.070
n-Hexane	0.078	0.34
Greenhouse Gases		
CH_4	3.28	14.35
CO_2e	68.81	301.38

a Assumes maximum development scenario

33. Gas Processing Plant Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	72	8,760	0.19	4.50E-03	9.95E-03	0.60
Connectors - Gas	247	8,760	0.19	2.00E-04	4.42E-04	0.091
Open-Ended Lines - Gas	9	8,760	0.19	2.00E-03	4.42E-03	0.033
Other - Gas	5	8,760	0.19	8.80E-03	1.94E-02	0.081
Total Gas Processing Plant VOC Emissions (tons/yr)[d]						**0.81**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{2000 \text{ (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.00086
Toluene Emissions	0.00011	0.00045
Ethylbenzene Emissions	----	----
Xylene Emissions	0.000011	0.000045
n-Hexane Emissions	0.0035	0.015

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	72	8,760	0.84	0.0027	0.121	1.35	0.012	28.45
Connectors - Gas	247	8,760	0.84	0.0027	0.017	0.65	0.0057	13.71
Open-Ended Lines - Gas	9	8,760	0.84	0.0027	0.031	0.043	0.00038	0.91
Other	5	8,760	0.84	0.0027	0.3	0.23	0.0020	4.90
Total Gas Processing Plant GHG Emissions (tons/yr)[d]						**2.05**	**0.018**	**43.07**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

34. Central Facility Heater Emissions

Assumptions

Gas Processing Dehydrator Reboiler Size	1,500	Mbtu/hr
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
	1	Gas Processing Plant
	20	Compressor Station

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Compressor Station Reboiler			Gas Processing Plant Reboiler			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.15	0.64	100	0.15	0.64	3.09	13.53
CO [a]	84	0.12	0.54	84	0.12	0.54	2.59	11.36
VOC [b]	5.5	0.008	0.035	5.5	0.008	0.035	0.17	0.74
SO_2 [b]	0.6	0.001	0.0039	0.6	0.001	0.0039	0.019	0.081
PM_{10} [b]	7.6	0.011	0.049	7.6	0.011	0.049	0.23	1.03
$PM_{2.5}$ [b]	7.6	0.011	0.049	7.6	0.011	0.049	0.23	1.03
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	3.09E-06	1.35E-05	2.10E-03	3.09E-06	1.35E-05	0.000065	0.00028
Toluene [c]	3.40E-03	5.00E-06	2.19E-05	3.40E-03	5.00E-06	2.19E-05	0.00011	0.00046
Hexane [c]	1.80E+00	2.65E-03	1.16E-02	1.80E+00	2.65E-03	1.16E-02	0.056	0.24
Formaldehyde [c]	7.50E-02	1.10E-04	4.83E-04	7.50E-02	1.10E-04	4.83E-04	0.0023	0.010
Dichlorobenzene [c]	1.2E-03	1.76E-06	7.73E-06	1.2E-03	1.76E-06	7.73E-06	0.000037	0.00016
Naphthalene [c]	6.1E-04	8.97E-07	3.93E-06	6.1E-04	8.97E-07	3.93E-06	0.000019	0.000083
POM 2 [c,d,e]	5.9E-05	8.68E-08	3.80E-07	5.9E-05	8.68E-08	3.80E-07	0.000002	0.000008
POM 3 [c,f]	1.6E-05	2.35E-08	1.03E-07	1.6E-05	2.35E-08	1.03E-07	0.0000005	0.000002
POM 4 [c,g]	1.8E-06	2.65E-09	1.16E-08	1.8E-06	2.65E-09	1.16E-08	0.0000001	0.0000002
POM 5 [c,h]	2.4E-06	3.53E-09	1.55E-08	2.4E-06	3.53E-09	1.55E-08	0.0000001	0.0000003
POM 6 [c,i]	7.2E-06	1.06E-08	4.64E-08	7.2E-06	1.06E-08	4.64E-08	0.0000002	0.000001
POM 7 [c,j]	1.8E-06	2.65E-09	1.16E-08	1.8E-06	2.65E-09	1.16E-08	0.0000001	0.0000002
Greenhouse Gases								
CO_2 [l]	119,226	175.3	768.0	119,226	175.3	768.0	3,682	16,127
CH_4 [l]	2.25	0.0033	0.014	2.25	0.0033	0.014	0.07	0.30
N_2O [l]	0.22	0.0003	0.001	0.22	0.0003	0.001	0.01	0.03
CO_2e [m]	---	175.5	768.7	---	175.5	768.7	3,686	16,143

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

35. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations 20
Number of Gas Processing Plants 1

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-flare)	Total Emissions (tons/yr-flare)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	18.76
CO [a]	0.37	1.11	4.86	102.10
Greenhouse Gases				
CO_2 [b]	---	402	1,759	36,935
CH_4 [b]	---	3.83	16.76	352.0
N_2O [b]	---	0.0007	0.003	0.062
CO_2e [b]	---	482	2,112	44,345

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

36. Electric Substation Turbines

Assumptions

Number of substations	6	Substations
Size of gas generators	20	MW
Size of steam generators	10	MW
Number of gas turbines per substation	2	turbines/substation
Number of steam turbines per substation	1	turbines/substation
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
20 MW turbine fuel input	189	MMBtu/hr
Turbine load factor	0.8	

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/MMBtu)} * \text{Fuel Input (MMBtu/hr)} * \text{turbines per facility} * \text{load factor} * \text{(hrs/year)}}{\text{2000 lbs/ton}}$$

	Emission Factor (lb/MMBtu)	Facility Emissions (lb/hr/facility)	Facility Emissions (tons/yr-facility)	Total Emissions [g] (lb/hr)	Total Emissions [g] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	0.0072	2.17	9.52	13.04	57.13
CO [a]	0.007	1.98	8.69	11.91	52.15
VOC [a]	0.0025	0.76	3.31	4.54	19.88
SO_2 [b]	0.00014	0.042	0.19	0.25	1.11
PM_{10} [c]	0.0048	1.45	6.37	8.72	38.21
$PM_{2.5}$ [c]	0.0048	1.45	6.37	8.72	38.21
Hazardous Air Pollutants [d]					
1,3-Butadiene	4.3E-07	0.00011	0.00049	0.00068	0.0030
Acetaldehyde	4.0E-05	0.011	0.046	0.063	0.28
Acrolein	6.4E-06	0.0017	0.0074	0.010	0.044
Benzene	1.2E-05	0.0032	0.014	0.019	0.083
Ethylbenzene	3.2E-05	0.0084	0.037	0.050	0.22
Formaldehyde	7.1E-04	0.19	0.817	1.12	4.90
Naphthalene	1.3E-06	0.00034	0.0015	0.0020	0.0090
PAH	2.2E-06	0.00058	0.0025	0.0035	0.015
Propylene Oxide	2.9E-05	0.0076	0.033	0.046	0.20
Toluene	1.3E-04	0.034	0.15	0.20	0.90
Xylene	6.4E-05	0.017	0.074	0.10	0.44
Greenhouse Gases					
CO2 [e]	117	35,409	155,093	212,457	930,560
CH_4 [e]	0.002	0.67	2.93	4.01	17.55
N_2O [e]	0.0002	0.067	0.29	0.40	1.76
CO_2e [f]	----	35,444	155,245	212,665	931,472

a Emission factors based on typical turbine specifications for turbines with catalysts to meet BACT levels - (2 ppmv NOx and VOC and 3 ppmv CO)

b Emission factor based on typical turbine manufacturer specifications

c Emission factor based on typical turbine manufacturer specifications and BACT levels

d Emission factors from AP-42, Table 3.1-3, HAPs from natural gas turbines, April 2000, with 13.3% control from the catalyst. Catalyst control efficiency from typical manufacturer data.

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH4 as 1.0E-03 kg/MMBtu and for N2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Assumes maximum development scenario. Emissions are from the 20 MW turbines as the 10 MW steam generators do not add any additional emissions

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

50 MMscfd

Calculated Absorber Stages:	2.51	
Specified Dry Gas Dew Point:	5.00	lbs. H2O/MMSCF
Temperature:	125.0	deg. F
Pressure:	800.0	psig
Dry Gas Flow Rate:	50.0000	MMSCF/day
Glycol Losses with Dry Gas:	1.8232	lb/hr
Wet Gas Water Content:	Saturated	
Calculated Wet Gas Water Content:	137.42	lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00	gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

50 MMscfd		
2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

50 MMscfd

Flow Rate: 1.46e+001 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

	50 MMscfd	
Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX E

ALTERNATIVE D – RESOURCE PROTECTION ALTERNATIVE EMISSIONS

APPENDIX E-1

RESOURCE PROTECTION ALTERNATIVE OIL WELL EMISSIONS

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Project: GMBU - Alternative D - Oil Wells

Date: 10/17/2014

Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative A - Oil Wells [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	17.7	6.3	1.5	0.0003	10.2	3.2
	Drilling	83.9	83.9	4.7	0.2	147.4	16.0
	Completion	38.1	18.9	6.8	0.023	265.9	28.1
	Interim Reclamation	0.2	0.2	0.02	0.0002	4.6	0.5
	Wind Erosion	---	---	---	---	1.8	0.3
Wellsite Production Emissions	Pump Unit Engines	1,465.0	1,999.9	396.6	1.9	159.7	159.7
	Production Heaters	280.2	235.4	15.4	1.7	21.3	21.3
	Wellsite Tanks	---	---	109.3	---	---	---
	Pneumatics	---	---	397.9	---	---	---
	Fugitives	---	---	1,198.0	---	---	---
	Wellsite Truck Loading	---	---	203.7	---	---	---
	Wellsite Flares	4.5	24.7	---	---	---	---
	Operations Vehicle	15.9	6.8	0.6	0.010	385.8	39.6
Water Treatment Facilities	Water Treatment Oil Tanks	---	---	281.5	---	---	---
	Water Treatment Fugitives	---	---	12.0	---	---	---
	Water Treatment Generator	244.2	488.3	170.9	0.6	19.3	19.3
Gas and Oil Separation Plants	GOSP Heaters	170.0	142.8	9.4	1.0	12.9	12.9
	GOSP Fugitives	---	---	139.3	---	---	---
	GOSP Generators	225.4	450.7	157.8	0.5	17.9	17.9
	GOSP Flare	10.7	58.3	---	---	---	---
	GOSP Truck Loadout and Vehicle Traffic	15.3	2.9	46.8	0.01	326.5	33.6
Compressor Station Emissions	Compressor Station Engines	309.0	618.0	216.3	0.7	11.2	11.2
	Compressor Station Tanks	---	---	5.2	---	---	---
	Compressor Station Dehydrator	---	---	46.8	---	---	---
	Compressor Station Truck Loading and Vehicle Traffic	0.3	0.1	11.1	0.0002	5.2	0.5
	Compressor Station Dehydrator Heater	2.6	2.2	0.1	0.02	0.2	0.2
	Compressor Station Flare	3.6	19.4	---	---	---	---
	Compressor Station Fugitives	---	---	12.1	---	---	---
	Total Emissions	**2,886.7**	**4,158.8**	**3,443.7**	**6.7**	**1,389.7**	**364.3**

a Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative D - Oil Wells

Date: 10/17/2014

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b]					Total
	Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
Criteria Pollutants & VOC						
NO_X	17.7	83.9	38.1	0.2	---	140.0
CO	6.3	83.9	18.9	0.2	---	109.3
VOC	1.5	4.7	6.8	0.02	---	13.0
SO_2	0.0003	0.2	0.02	0.0002	---	0.2
PM_{10}	10.2	147.4	265.9	4.6	1.8	429.7
$PM_{2.5}$	3.2	16.0	28.1	0.5	0.3	48.1
Hazardous Air Pollutants						
Benzene	---	0.07	0.012	---	---	0.084
Toluene	---	0.03	0.005	---	---	0.031
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.02	0.0018	---	---	0.020
n-Hexane	---	---	0.095	---	---	0.095
Formaldehyde	---	0.007	0.0006	---	---	0.0080
Acetaldehyde	---	0.002	0.00020	---	---	0.0026
Acrolein	---	0.0007	0.00006	---	---	0.00080
Naphthalene	---	0.012	0.0010	---	---	0.013
POM 2	---	0.007	0.0006	---	---	0.0078
POM 5	---	0.00006	0.000005	---	---	0.000061
POM 6	---	0.0002	0.000019	---	---	0.00024
POM 7	---	0.0001	0.000012	---	---	0.00016
Greenhouses Gases						
CO_2	424.2	15,975	2,565	21	---	18,986
CH_4	0.001	0.64	18.17	0.001	---	18.81
N_2O	0.0004	0.13	0.02	0.0002	---	0.15
CO_2e	424.4	16,029	2,954	21	---	19,428

a Assumes maximum development scenario of 204 wells in one year

b Emissions in summary tables may vary slightly due to rounding differences.

c Total drilling emissions includes Tier IV drill rig engines

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Project: GMBU - Alternative D - Oil Wells

Date: 10/17/2014

Total Project Production Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]								
	Well Pump Engines	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Wellsite Flares	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	1465.0	280.2	---	---	---	---	4.5	15.9	1,765.7
CO	1999.9	235.4	---	---	---	---	24.7	6.8	2,266.8
VOC	396.6	15.4	109.3	1198.0	203.7	397.9	---	0.6	2,321.5
SO_2	1.9	1.7	---	---	---	---	---	0.010	3.6
PM_{10}	159.7	21.3	---	---	---	---	---	385.8	566.7
$PM_{2.5}$	159.7	21.3	---	---	---	---	---	39.6	220.5
Hazardous Air Pollutants									
Benzene	6.41	0.0059	0.35	3.31	0.65	0.42	---	---	11.15
Toluene	3.18	0.010	0.32	2.97	0.60	0.22	---	---	7.30
Ethylbenzene	0.36	---	0.02	0.16	0.03	---	---	---	0.57
Xylene	0.89	---	0.10	0.92	0.19	0.022	---	---	2.12
n-Hexane	1.47	5.04	5.47	52.55	10.19	7.35	---	---	82.08
Formaldehyde	182.44	0.21	---	---	---	---	---	---	182.65
Acetaldehyde	25.65	---	---	---	---	---	---	---	25.65
Acrolein	25.71	---	---	---	---	---	---	---	25.71
Methanol	8.20	---	---	---	---	---	---	---	8.20
1,1,2,2-Tetrachloroethane	0.22	---	---	---	---	---	---	---	0.22
1,1,2-Trichloroethane	0.17	---	---	---	---	---	---	---	0.17
1,3-Dichloropropene	0.14	---	---	---	---	---	---	---	0.14
1,3-Butadiene	2.71	---	---	---	---	---	---	---	2.71
2,2,4-Trimethylpentane	2.80	---	---	---	---	---	---	---	2.80
Biphenyl	0.013	---	---	---	---	---	---	---	0.013
Carbon Tetrachloride	0.20	---	---	---	---	---	---	---	0.20
Chlorobenzene	0.15	---	---	---	---	---	---	---	0.15
Chloroform	0.16	---	---	---	---	---	---	---	0.16
Dichlorobenzene	---	0.0034	---	---	---	---	---	---	0.0034
Ethylene Dibromide	0.24	---	---	---	---	---	---	---	0.24
Methylene Chloride	0.49	---	---	---	---	---	---	---	0.49
Naphthalene	0.32	0.0017	---	---	---	---	---	---	0.32
Phenol	0.14	---	---	---	---	---	---	---	0.14
Styrene	0.18	---	---	---	---	---	---	---	0.18
Vinyl Chloride	0.082	---	---	---	---	---	---	---	0.082
PAH -POM 1	0.44	---	---	---	---	---	---	---	0.44
POM 2	0.11	0.00017	---	---	---	---	---	---	0.11
POM 3	---	0.000045	---	---	---	---	---	---	0.000045
POM 4	---	0.0000050	---	---	---	---	---	---	0.0000050
POM 5	0.000019	0.0000067	---	---	---	---	---	---	0.000025
POM 6	0.0012	0.000020	---	---	---	---	---	---	0.0012
POM 7	0.0022	0.0000050	---	---	---	---	---	---	0.0022
Greenhouse Gases									
CO_2	386,316	334,060	17.0	16.9	1.58	12.29	8,539	1,391	730,353
CH_4	7.29	6.30	26.2	1929.1	48.78	1,403	26.2	0.0155	3,447
N_2O	0.73	0.63	---	---	---	---	0.0086	0.0035	1.37
CO_2e	386,694	334,387	567	40,529	1,026	29,474	9,092	1,392	803,161

a Assumes maximum development scenario of 3250 wells

b Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU - Alternative D - Oil Wells

Date: 10/17/2014

Total Project Infrastructure Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]									
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Generators	Central Facility Flares	Dehydrators	Compressor Engines	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC										
NO_X	172.6	---	---	---	469.5	14.3	---	309.0	15.6	981.0
CO	145.0	---	---	---	939.1	77.8	---	618.0	3.0	1,782.8
VOC	9.5	286.7	163.4	57.4	328.7	---	46.8	216.3	0.5	1,109.2
SO_2	1.0	---	---	---	1.1	---	---	0.7	0.01	2.8
PM_{10}	13.1	---	---	---	37.2	---	---	11.15	331.7	393.2
$PM_{2.5}$	13.1	---	---	---	37.2	---	---	11.15	34.2	95.6
Hazardous Air Pollutants										
Benzene	0.004	0.95	0.41	0.26	1.51	---	2.24	0.25	---	5.61
Toluene	0.006	0.91	0.36	0.32	0.53	---	1.58	0.23	---	3.93
Ethylbenzene	---	0.050	0.018	0.015	0.024	---	---	0.0223	---	0.129
Xylene	---	0.29	0.11	0.11	0.19	---	0.28	0.103	---	1.08
n-Hexane	3.11	14.22	6.30	2.60	---	---	1.36	0.62	---	28.22
Formaldehyde	0.13	---	---	---	19.65	---	---	29.60	---	49.38
Acetaldehyde	---	---	---	---	2.67	---	---	4.69	---	7.36
Acrolein	---	---	---	---	2.52	---	---	2.88	---	5.40
Methanol	---	---	---	---	2.93	---	---	1.40	---	4.33
1,1,2,2-Tetrachloroethane	---	---	---	---	0.024	---	---	0.0224	---	0.047
1,1,2-Trichloroethane	---	---	---	---	0.015	---	---	0.0178	---	0.032
1,3-Dichloropropene	---	---	---	---	0.012	---	---	0.0148	---	0.027
1,3-Butadiene	---	---	---	---	0.64	---	---	0.150	---	0.79
2,2,4-Trimethylpentane	---	---	---	---	---	---	---	0.140	---	0.14
Biphenyl	---	---	---	---	---	---	---	0.119	---	0.12
Carbon Tetrachloride	---	---	---	---	0.017	---	---	0.0206	---	0.038
Chlorobenzene	---	---	---	---	0.012	---	---	0.0170	---	0.029
Chloroform	---	---	---	---	0.013	---	---	0.0160	---	0.029
Dichlorobenzene	0.0021	---	---	---	---	---	---	---	---	0.0021
Ethylene Dibromide	---	---	---	---	0.020	---	---	0.0248	---	0.045
Methylene Chloride	---	---	---	---	0.039	---	---	0.0112	---	0.05
Naphthalene	0.0011	---	---	---	0.093	---	---	0.042	---	0.14
Phenol	---	---	---	---	---	---	---	0.0135	---	0.013
Styrene	---	---	---	---	0.011	---	---	0.0132	---	0.025
Tetrachloroethane	---	---	---	---	---	---	---	0.00139	---	0.0014
Vinyl Chloride	---	---	---	---	0.007	---	---	0.0084	---	0.015
PAH -POM 1	---	---	---	---	0.14	---	---	0.015	---	0.15
POM 2	0.00010	---	---	---	---	---	---	0.033	---	0.033
POM 3	0.000028	---	---	---	---	---	---	---	---	0.000028
POM 4	0.0000031	---	---	---	---	---	---	---	---	0.0000031
POM 5	0.0000041	---	---	---	---	---	---	---	---	0.0000041
POM 6	0.000012	---	---	---	---	---	---	0.000093	---	0.00011
POM 7	0.000003	---	---	---	---	---	---	0.00039	---	0.00039
Greenhouse Gases										
CO_2	205,812	23.25	2.4	2.607	224,045	35,625	---	131,064	1,315	597,890
CH_4	3.88	72.40	278.1	21.74	4.23	228	57.40	2.47	0.008	667.8
N_2O	0.39	---	---	---	0.42	0.05	---	0.25	0.001	1.1
CO_2e	206,013	1,544	5,843	459	224,265	40,418	1,206	131,193	1,316	612,256

a Assumes maximum development scenario of 3250 wells

b Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU - Alternative D - Oil Wells

Date: 10/17/2014

Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	140.0	1,765.7	981.0	2,886.7
CO	109.3	2,266.8	1,782.8	4,158.8
VOC	13.0	2,321.5	1,109.2	3,443.7
SO_2	0.2	3.6	2.8	6.7
PM_{10}	429.7	566.7	393.2	1,389.7
$PM_{2.5}$	48.1	220.5	95.6	364.3
Hazardous Air Pollutants				
Benzene	0.084	11.15	5.61	16.84
Toluene	0.031	7.30	3.93	11.26
Ethylbenzene	---	0.57	0.13	0.70
Xylene	0.020	2.12	1.08	3.22
n-Hexane	0.095	82.08	28.22	110.39
Formaldehyde	0.0080	182.65	49.38	232.03
Acetaldehyde	0.0026	25.65	7.36	33.01
Acrolein	0.00080	25.71	5.40	31.12
Methanol	---	8.20	4.33	12.53
1,1,2,2-Tetrachloroethane	---	0.219	0.047	0.27
1,1,2-Trichloroethane	---	0.174	0.032	0.21
1,3-Dichloropropene	---	0.145	0.027	0.17
1,3-Butadiene	---	2.71	0.79	3.50
2,2,4-Trimethylpentane	---	2.80	0.14	2.94
Biphenyl	---	0.013	0.12	0.13
Carbon Tetrachloride	---	0.201	0.038	0.24
Chlorobenzene	---	0.147	0.029	0.18
Chloroform	---	0.156	0.029	0.18
Dichlorobenzene	---	0.0034	0.0021	0.0054
Ethylene Dibromide	---	0.243	0.045	0.29
Methylene Chloride	---	0.49	0.051	0.54
Naphthalene	0.0132	0.32	0.14	0.47
Phenol	---	0.139	0.013	0.15
Styrene	---	0.181	0.025	0.21
Vinyl Chloride	---	0.082	0.015	0.097
(PAH) POM 1	---	0.44	0.15	0.59
POM 2	0.0078	0.109	0.033	0.15
POM 3	---	0.000045	0.000028	0.000072
POM 4	---	0.0000050	0.0000031	0.0000082
POM 5	0.000061	0.000025	0.0000041	0.000091
POM 6	0.000240	0.00118	0.00011	0.0015
POM 7	0.000155	0.00223	0.0004	0.0028
Total HAPs	0.26	353.99	107.16	461.42
Greenhouse Gases				
CO_2	18,986	730,353	597,890	1,347,228
CH_4	18.81	3,447	668	4,133.4
N_2O	0.154	1.37	1.11	2.63
CO_2e	19428	803,161	612,256	1,434,846

a Emissions for Peak Field Development
b Emissions in summary tables may vary slightly due to rounding differences.

1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	1	days per well pad
	12	hours per day
	12	hours per well pad
Annual amount of well pads	204	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = 5.7 * (soil silt content %)$^{1.2}$ * (soil moisture content %)$^{-1.3}$* Control Efficiency
Emissions (PM_{15} lbs/hr) = 1.0 * (soil silt content %)$^{1.5}$ * (soil moisture content %)$^{-1.4}$ * Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment
Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.012	2.41	1.97	0.012	2.41	4.82
PM_{15}	0.50	0.003	0.61	0.50	0.003	0.61	1.23
PM_{10}	0.38	0.002	0.46	0.38	0.002	0.46	0.92
$PM_{2.5}$	0.21	0.001	0.25	0.21	0.001	0.25	0.51

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.
b Assumes maximum development scenario

2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	1	day grading per well pad
	12	hours/day
	12	hours per well pad
Deep gas well pads	0	well pads/year
Oil well pads	204	well pads/year
Distance graded - Oil well	0.45	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Oil wells			**Total Emissions**
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	1.22	0.10	0.0006	0.125
PM_{15}	0.58	0.049	0.00029	0.060
PM_{10}	0.35	0.029	0.00018	0.036
$PM_{2.5}$	0.04	0.003	0.000019	0.0039

a Assumes maximum development scenario

3. Road Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	4	days per mile
	12	hours per day
	0.17	miles of road per well pad
	8	hours per well pad road
Annual amount of well pads with roads	204	pads with roads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content }\%)^{1.2} * (\text{soil moisture content }\%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.008	1.61	1.97	0.008	1.61	3.23
PM_{15}	0.50	0.002	0.41	0.50	0.002	0.41	0.82
PM_{10}	0.38	0.002	0.31	0.38	0.002	0.31	0.62
$PM_{2.5}$	0.21	0.0008	0.17	0.21	0.001	0.17	0.339

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

4. Road Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	8	hours per well pad roads
Road construction grading distance	0.33	miles road per well pad
Annual well pads	204	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Roads			Total Emissions
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	0.90	0.11	0.0004	0.092
PM_{15}	0.43	0.05	0.00022	0.044
PM_{10}	0.26	0.032	0.00013	0.0263
$PM_{2.5}$	0.03	0.003	0.000014	0.00284

a Assumes maximum development scenario

5. Pipeline Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	10	days per mile
	12	hours per day
	0.17	miles of pipeline per well pad
	20	hours per well pad pipeline
Annual amount of well pads withpipeline	204	pads with pipeline/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content }\%)^{1.2} * (\text{soil moisture content }\%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment
Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.020	4.04	1.97	0.020	4.04	8.07
PM_{15}	0.50	0.005	1.03	0.50	0.005	1.03	2.06
PM_{10}	0.38	0.0038	0.77	0.38	0.0038	0.77	1.54
$PM_{2.5}$	0.21	0.0021	0.42	0.21	0.0021	0.42	0.85

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.
b Assumes maximum development scenario

6. Pipeline Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	20	hours per well pad pipeline
Pipeline construction grading distance	0.67	miles pipeline per well pad
Annual well pads	204	well pads/year
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Pipeline			Total Emissions
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/year[a]**
TSP	1.80	0.09	0.0009	0.183
PM_{15}	0.86	0.043	0.00043	0.088
PM_{10}	0.52	0.026	0.00026	0.053
$PM_{2.5}$	0.06	0.0028	0.000028	0.0057

a Assumes maximum development scenario

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7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual
$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual
$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily
$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S) 5.1 AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles 19
Precipitation Days (P) 45 days per year (NCDC data for Ouray, UT 1955-2004)
W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily
$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles 6
Precipitation Days (P) 45 days per year
W = average weight in tons of vehicles traveling the road

Construction Emissions

Hours per day 12 hour/day
Days per pad 1 day/well pad
Number of pads per year 204 well pads/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-pad**	**ton/year-pad**	**ton/year**
PM_{10}	1.20	1.05	5.61	0.03	6.02
$PM_{2.5}$	0.12	0.11	0.56	0.003	0.60

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-pad**	**ton/year-pad**	**ton/year**
PM_{10}	0.015	0.014	0.023	0.00013	0.03
$PM_{2.5}$	0.0036	0.0035	0.0056	0.00003	0.007

Drilling - Oil Wells

Hours per day 24 hour/day
Days per oil well 6 day/well
Number of wells per year 204 wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	3
Light Trucks	8,000	5
Mean Vehicle Weight	25,000	---
Total Round Trips	---	11

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-well**	**ton/year-well**	**ton/year**
PM_{10}	1.32	1.16	11.29	0.71	145.36
$PM_{2.5}$	0.13	0.12	1.13	0.07	14.54

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-well**	**ton/year-well**	**ton/year**
PM_{10}	0.018	0.018	0.052	0.0036	0.74
$PM_{2.5}$	0.0045	0.0043	0.013	0.0009	0.18

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7. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual

$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily

$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Interim Reclamation

Hours per day	12	hour/day
Days per pad	1	day/well pad
Number of wells per year	204	wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	1.35	1.19	4.21	0.02	4.52
$PM_{2.5}$	0.14	0.12	0.42	0.002	0.45

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-pad	ton/year-pad	ton/year
PM_{10}	0.019	0.019	0.020	0.00012	0.02
$PM_{2.5}$	0.0047	0.0046	0.0049	0.00003	0.006

Completion - Oil Well

Hours per day	24	hour/day
Days per oil well	7	day/well
Number of wells per year	204	wells /year

Vehicle Type[a]	Weight (lbs)	Oil Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	7
Haul Trucks	45,000	2
Light Trucks	8,000	7
Mean Vehicle Weight	28,813	---
Total Round Trips	---	16

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	1.41	1.23	17.50	1.29	262.95
$PM_{2.5}$	0.14	0.12	1.75	0.13	26.29

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-well	ton/year-well	ton/year
PM_{10}	0.021	0.020	0.087	0.007	1.44
$PM_{2.5}$	0.0052	0.0050	0.021	0.0017	0.35

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	Paved Total tons/year	Total tons/year
PM_{10}	418.86	2.23	421.08
$PM_{2.5}$	41.89	0.55	42.43

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

8. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	340	acres total disturbance for roads and pipelines per year
	1,375,676	square meters total initial disturbance for roads and pipelines
	155	acres total disturbance for well pads per year
	627,424	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed (U_{10}^{+})	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\,U_{10}^{+}$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, $P = 0$ for $U^*< U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	3.54	0.00
PM_{10}	1.77	0.00
$PM_{2.5}$	0.27	0.00

9. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction	1	days per well pad
Well pads per year	204	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{2000 \text{ (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0009	7.39E-03	0.031	0.00018	0.18	0.23
CO	1.98E-02	0.041	0.00025	7.26E-02	0.30	0.0018	0.34	0.42
VOC	3.16E-03	0.0065	0.00004	3.54E-03	0.015	0.00009	0.021	0.026
SO_2	4.57E-05	0.000095	0.0000006	2.83E-05	0.00012	0.0000007	0.00021	0.00026
PM_{10}	4.22E-03	0.0087	0.00005	1.94E-04	0.00080	0.000005	0.010	0.012
$PM_{2.5}$	4.09E-03	0.0085	0.00005	1.79E-04	0.00074	0.000004	0.0092	0.011
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.08	1.61E+00	6.67	0.04	20.61	25.23
CH_4	6.56E-05	0.00014	0.0000008	2.08E-04	0.00086	0.000005	0.0010	0.0012
N_2O	1.20E-05	0.000025	0.00000015	8.05E-05	0.00033	0.0000020	0.00036	0.0004
CO_2e [d]	---	13.95	0.08	---	6.79	0.04	20.75	25.39

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	204	new pads per year
Backhoe miles per pad	0.36	miles (Value assumed to be 1/4 of dozer or grader mileage)
Backhoe Hours	40.1	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer miles per pad	1.5	miles
Dozer Hours	40.1	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Grader miles per pad	1.5	miles
Motor Grader Hours	40.1	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horse Power} * \text{Hours} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)
Criteria Pollutants & VOC									
NOx	6.9	0.28	0.0056	8.38	1.48	0.030	8.38	2.52	0.051
CO	3.49	0.14	0.0028	2.7	0.48	0.010	2.70	0.81	0.016
VOC [b]	0.99	0.040	0.0008	0.68	0.12	0.0024	0.68	0.20	0.0041
PM_{10}	0.722	0.029	0.0006	0.402	0.071	0.0014	0.402	0.12	0.0024
$PM_{2.5}$	0.722	0.029	0.0006	0.402	0.071	0.0014	0.402	0.12	0.0024
Greenhouse Gases									
CO_2 [c]	188.2	7.59	0.15	188.2	33.31	0.67	188.2	56.59	1.14
CO_2e [e]	---	7.59	0.15	---	33.31	0.67	---	56.59	1.14

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC		
NOx	4.28	17.52
CO	1.43	5.86
VOC	0.36	1.49
PM_{10}	0.22	0.91
$PM_{2.5}$	0.22	0.91
Greenhouse Gases		
CO_2	97.50	399.01
CO_2e [e]	97.50	399.01

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor: 73.96 kg CO_2/mmBtu
393 hp-hr = mmBtu
188.2 g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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Project: GMBU - Alternative D - Oil Wells

Date: 10/17/2014

11. Drilling Tailpipe Emissions

Assumptions:

Number of oil wells drilled	204	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	144	hours per site (oil well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (oil well)
Number of Pickup Trips	5	trips/day-well (oil well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{2000 \text{ (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks-Oil Wells			Heavy Duty Pickups-Oil Wells			Total-Oil Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.033	7.39E-03	0.038	0.0028	0.50	7.35
CO	1.98E-02	0.12	0.0089	7.26E-02	0.38	0.027	0.50	7.33
VOC [c]	3.16E-03	0.020	0.0014	3.54E-03	0.018	0.0013	0.038	0.56
SO_2	4.57E-05	0.00028	0.000020	2.83E-05	0.00015	0.000011	0.00043	0.0063
PM_{10}	4.22E-03	0.026	0.0019	1.94E-04	0.0010	0.000072	0.027	0.40
$PM_{2.5}$	4.09E-03	0.025	0.0018	1.79E-04	0.00093	0.000067	0.026	0.39
Greenhouse Gases								
CO_2	6.73E+00	41.83	3.01	1.61E+00	8.34	0.60	50.17	736.83
CH_4	6.56E-05	0.00041	0.000029	2.08E-04	0.0011	0.000078	0.0015	0.022
N_2O	1.20E-05	0.000075	0.0000054	8.05E-05	0.00042	0.000030	0.00049	0.0072
CO_2e [d]	---	41.86	3.01	---	8.49	0.61	50.35	739.53

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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12. Completion Tailpipe Emissions

Assumptions:

Number of oil wells	204	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	168	hours per site (oil well)
Number of Heavy Diesel Truck Trips	9	trips/day-well (oil well)
Number of Pickup Trips	7	trips/day-well (oil well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	Heavy Haul Trucks-Oil Wells			Heavy Duty Pickups-Oil Wells			Total_Oil Wells [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.69	0.058	7.39E-03	0.054	0.0045	0.75	12.80
CO	1.98E-02	0.18	0.016	7.26E-02	0.53	0.044	0.71	12.18
VOC [c]	3.16E-03	0.029	0.0025	3.54E-03	0.026	0.0022	0.055	0.94
SO_2	4.57E-05	0.00043	0.000036	2.83E-05	0.00021	0.000017	0.00063	0.011
PM_{10}	4.22E-03	0.039	0.0033	1.94E-04	0.0014	0.00012	0.041	0.70
$PM_{2.5}$	4.09E-03	0.038	0.0032	1.79E-04	0.0013	0.00011	0.039	0.68
Greenhouse Gases								
CO_2	6.73E+00	62.74	5.27	1.61E+00	11.67	0.98	74.41	1275.16
CH_4	6.56E-05	0.00061	0.000051	2.08E-04	0.0015	0.00013	0.0021	0.036
N_2O	1.20E-05	0.00011	0.0000094	8.05E-05	0.00058	0.000049	0.00070	0.012
CO_2e [d]	---	62.79	5.27	---	11.89	1.00	74.67	1279.62

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

13. Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	204	
Average Round Trip Distance	24.9	miles
Hours of Operation	12	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/well)} * \text{Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0009	7.39E-03	0.015	0.00009	0.169	0.21
CO	1.98E-02	0.041	0.00025	7.26E-02	0.15	0.0009	0.19	0.23
VOC [c]	3.16E-03	0.0065	0.00004	3.54E-03	0.0073	0.00004	0.0139	0.017
SO_2	4.57E-05	0.00009	0.0000006	2.83E-05	0.000059	0.0000004	0.00015	0.00019
PM_{10}	4.22E-03	0.0087	0.00005	1.94E-04	0.00040	0.0000024	0.0091	0.011
$PM_{2.5}$	4.09E-03	0.0085	0.00005	1.79E-04	0.00037	0.0000022	0.0088	0.011
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.08	1.61E+00	3.34	0.020	17.28	21.15
CH_4	6.56E-05	0.00014	0.0000008	2.08E-04	0.00043	0.0000026	0.00057	0.0007
N_2O	1.20E-05	0.000025	0.00000015	8.05E-05	0.00017	0.0000010	0.00019	0.00023
CO_2e [d]	---	13.95	0.08	---	3.40	0.020	17.35	21.24

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

14. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation	144	hours/oil well
Development Rate	204	oil wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

$$\text{Emissions (ton/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{horsepower (hp)} * \text{Hours (hour/year)} * \text{Load factor}}{\text{2000 lb/ton}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1, 10/96

Drill Rig Emissions (Tier 4)

Species	Drill Rig E. Factor (lb/hp-hr)	Drill Rig Emissions (lb/hr)	Oil Well Drill Rig Emissions (tons/yr-well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC				
NOx [a]	5.73E-03	5.21	0.38	76.53
CO [a]	5.73E-03	5.21	0.38	76.53
VOC [a]	3.09E-04	0.28	0.02	4.12
PM_{10} [a]	6.61E-05	0.06	0.004	0.88
$PM_{2.5}$ [a]	6.61E-05	0.06	0.004	0.88
SO_2 [b]	1.21E-05	0.011	0.00079	0.16
Hazardous Air Pollutants				
Benzene [c]	5.43E-06	0.0049	0.00036	0.073
Toluene [c]	1.97E-06	0.0018	0.00013	0.026
Xylenes [c]	1.35E-06	0.0012	0.000088	0.018
Formaldehyde [c]	5.52E-07	0.00050	0.000036	0.0074
Acetaldehyde [c]	1.76E-07	0.00016	0.000012	0.0024
Acrolein [c]	5.52E-08	0.00005	0.0000036	0.00074
Naphthalene [d]	9.10E-07	0.00083	0.000060	0.012
POM 2 [d,e,f]	5.39E-07	0.00049	0.000035	0.0072
POM 5 [d,e,g]	4.22E-09	0.0000038	0.00000028	0.000056
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000011	0.00022
POM 7 [d,e,i]	1.07E-08	0.000010	0.00000070	0.00014
Greenhouse Gases				
CO_2 [j]	1.14	1037.47	74.70	15,238
CH_4 [j,k]	4.63E-05	0.042	0.0030	0.62
N_2O [j,k]	9.26E-06	0.0084	0.00061	0.12
CO_2e [m]	---	1040.96	74.95	15,290

a Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM) Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr

d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

i POM 7 includes: Chrysene.

j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

l Assumes maximum development scenario

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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15. Well Fracturing Engine

Average Gallons of Diesel used per Frac Job	566	gallons/well (oil well)
Hours per frac job	25.2	hours/well (oil well)
Development Rate - Oil Wells	204	wells/year (oil wells)
Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Diesel Density	7.1	lb/gal
Diesel Heating Value	19,300	BTU/lb

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

$$\text{Emissions (tons/year)} = \frac{\text{EF (lb/MMBtu)*Density (lb/gal)*Heat Value (Btu/lb)*Fuel per Well (gal/well)}}{\text{1000000 (Btu/MMBtu)*2000 (lb/tons)}}$$

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

Species	Frac Engine Emissions				
	E. Factor (lb/MMBtu)	E. Factor (lb/hp-hr)	Engine Emissions (lb/hr)	Engine Emissions (tons/yr-well)	Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	3.2	0.024	9.84	0.12	25.32
CO [a]	0.85	5.50E-03	2.62	0.033	6.72
VOC [a]	0.09	7.05E-04	0.28	0.0035	0.71
PM_{10} [a]	0.10	0.0007	0.31	0.0039	0.79
$PM_{2.5}$ [a]	0.10	0.0007	0.31	0.0039	0.79
SO_2 [a]	1.52E-03	1.21E-05	0.0047	0.000059	0.012
Hazardous Air Pollutants					
Benzene [b]	7.76E-04	5.43E-06	0.0024	0.000030	0.0061
Toluene [b]	2.81E-04	1.97E-06	0.00086	0.000011	0.0022
Xylenes [b]	1.93E-04	1.35E-06	0.00059	0.0000075	0.0015
Formaldehyde [b]	7.89E-05	5.52E-07	0.00024	0.0000031	0.00062
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000078	0.0000010	0.00020
Acrolein [b]	7.88E-06	5.52E-08	0.000024	0.00000031	0.000062
Naphthalene [c]	1.30E-04	9.10E-07	0.00040	0.0000050	0.0010
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00024	0.0000030	0.00061
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000019	0.000000023	0.0000048
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000073	0.000000092	0.000019
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000047	0.000000059	0.000012
Greenhouse Gases					
CO_2 [i]	163.05	1.14	501.6	6.32	1289.9
CH_4 [j]	6.61E-03	4.63E-05	0.020	0.00026	0.052
N_2O [j]	1.32E-03	9.26E-06	0.0041	0.000051	0.010
CO_2e [l]	---	---	503.3	6.3	1,294.3

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

16. Oil Well Development Venting

Following completion, oil wells are vented prior to connnection to the gathering pipeline. Gas wells are connected to a sales line during completion.

Amount of Vented Gas:	5.0	Mscf per well (Average volume estimated)
Development Rate:	204	oil wells per year
Control Rate	0	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/well)	Component Emission Rate (tons/well)	Total Emission Rate[a] (tons)
Methane	16.04	83.858	13.453	0.674	4.193	8.86E-02	18.08
Ethane	30.07	7.944	2.389	0.120	0.397	1.57E-02	3.21
Propane	44.10	4.313	1.902	0.095	0.216	1.25E-02	2.56
i-Butane	58.12	0.687	0.399	0.020	0.034	2.63E-03	0.54
n-Butane	58.12	1.284	0.746	0.037	0.064	4.92E-03	1.00
i-Pentane	72.15	0.332	0.240	0.012	0.017	1.58E-03	0.32
n-Pentane	72.15	0.375	0.270	0.014	0.019	1.78E-03	0.36
Hexanes	86.18	0.134	0.116	0.00580	0.0067	7.63E-04	0.16
Heptanes	100.20	0.055	0.055	0.00274	0.0027	3.60E-04	0.074
Octanes	114.23	0.0085	0.010	0.00049	0.0004	6.40E-05	0.013
Nonanes	128.26	0.00080	0.001	0.00005	0.00004	6.76E-06	0.0014
Decanes +	142.29	0.00010	0.0001	0.00001	0.00001	9.37E-07	0.00019
Benzene	78.12	0.0052	0.004	0.00020	0.0003	2.68E-05	0.0055
Toluene	92.13	0.0023	0.002	0.00011	0.0001	1.40E-05	0.0028
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.000	0.00001	0.00001	1.40E-06	0.00029
n-Hexane	86.18	0.082	0.070	0.00353	0.0041	4.64E-04	0.095
Helium	4.00	----	---	---	---	---	---
Nitrogen	28.01	0.647	0.181	0.00908	0.0323	1.19E-03	0.24
Carbon Dioxide	44.01	0.268	0.118	0.00591	0.0134	7.76E-04	0.16
Oxygen	32.00	----	---	---	---	---	---
Hydrogen Sulfide	34.08	0.005	0.002	0.00009	0.0003	1.12E-05	0.0023
VOC Subtotal		**7.28**	**3.82**	**0.19**	**0.4**	**0.025**	**5.13**
HAP Subtotal		**0.09**	**0.08**	**0.004**	**0.004**	**0.0005**	**0.10**
Total		**100**	**19.96**	**1.00**	**5.00**	**0.13**	**26.82**

a Assumes maximum development scenario

17. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet): 1181.9 Btu/scf

C1-C2 Wt. Fraction: 0.794
VOC Wt. Fraction: 0.191
Non-HC Wt. Fraction: 0.015
Total: 1.000

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

Project: GMBU - Alternative D - Oil Wells

Date: ########

18. Operations Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	575,626	miles/year-all wells
Operation Pickup Truck Mileage:	171,615	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	8.45	15.43	6.05E-03	0.28	0.52	8.74	15.95
CO	1.02E-02	1.61	2.94	4.48E-02	2.11	3.84	3.71	6.78
VOC [c]	1.55E-03	0.24	0.45	1.61E-03	0.08	0.14	0.32	0.58
SO_2	3.07E-05	0.005	0.009	1.84E-05	0.0009	0.0016	0.006	0.010
PM_{10}	2.57E-03	0.41	0.74	1.31E-04	0.006	0.011	0.41	0.75
$PM_{2.5}$	2.50E-03	0.39	0.72	1.21E-04	0.006	0.010	0.40	0.73
Greenhouse Gases								
CO_2	4.520	712.8	1,300.9	1.050	49.4	90.1	762.2	1,391.0
CH_4	2.59E-05	0.0041	0.007	9.38E-05	0.004	0.008	0.008	0.016
N_2O	4.01E-06	0.0006	0.0012	2.68E-05	0.0013	0.0023	0.0019	0.0035
CO_2e [c]	---	713.1	1,301.4	---	49.9	91.0	763.0	1392.4

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

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19. Operations Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of wells not producing to GOSP	1450	wells

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.56	1.37	0.16	0.26	382.52
$PM_{2.5}$	0.16	0.14	0.016	0.026	38.25

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	63
Light Trucks	8,000	19
Mean Vehicle Weight	36,457	---
Total Round Trips	---	82

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.027	0.027	0.00094	0.0017	2.47
$PM_{2.5}$	0.0066	0.0066	0.00023	0.00042	0.61

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

20. Oil Storage Tank Working/Breathing Emissions

Assumptions:

Oil Production Rate :	13,195	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	725	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	725	well pads
Control Efficiency of tanks:	95	%
Average Throughput:	139,503	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Uncontrolled Tank W&B (tons/yr/tank)	Controlled Tank W&B (tons/yr/tank)	Total Wellsite W&B [a] (tons/yr)
Total VOC	0.62	0.031	45.18
Hazardous Air Pollutants [b]			
Benzene	0.0020	0.000099	0.14
Toluene	0.0018	0.000091	0.13
Ethylbenzene	0.000102	0.0000051	0.007
Xylenes	0.00058	0.000029	0.042
n-Hexane	0.031	0.0016	2.26
Greenhouse Gases [b]			
CO_2	0.0048	0.0048	7.02
CH_4	0.15	0.0075	10.82
CO_2e	3.14	0.16	234.21

a Total wellsite working and breathing emissions are based on 0 uncontrolled tanks and 1450 tanks controlled at 95%.
b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

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21. Oil Storage Tank Flashing Emissions

Assumptions:

Oil Production Rate :	13,195	bbls oil per day - all wells (not to GOSP)
Number of Well Pads with Tanks:	725	well pads
Tanks per wellsite:	2	tanks
Number of well pads with controls:	725	well pads
Control Efficiency of tanks:	95	%
Tank Vent GOR:	7.76	scf/bbl

Vent Rate = 102.39 Mscf/day

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT PERCENT	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	16.58	39.82	307.20
Ethane	30.07	16.516	4.97	13.20	16.91	244.55
Propane	44.10	16.909	7.46	19.81	17.31	367.19
i-Butane	58.12	3.694	2.15	5.71	3.78	105.72
n-Butane	58.12	9.044	5.26	13.97	9.26	258.83
i-Pentane	72.15	3.269	2.36	6.27	3.35	116.14
n-Pentane	72.15	4.297	3.10	8.24	4.40	152.66
Cyclopentane	70.10	0.361	0.25	0.67	0.37	12.46
Hexanes	86.18	2.285	1.97	5.23	2.34	96.97
Heptanes	100.20	1.423	1.43	3.79	1.46	70.21
Octanes	114.23	0.403	0.46	1.22	0.41	22.67
Nonanes	128.26	0.076	0.10	0.26	0.078	4.80
Decanes +	142.29	0.026	0.037	0.098	0.027	1.82
Benzene	78.11	0.106	0.083	0.22	0.109	4.08
Toluene	92.14	0.083	0.076	0.20	0.085	3.77
Ethylbenzene	106.17	0.004	0.004	0.011	0.0041	0.21
Xylenes	106.17	0.023	0.024	0.065	0.0236	1.20
n-Hexane	86.18	1.513	1.30	3.46	1.55	64.21
Nitrogen	28.01	0.612	0.17	0.46	0.63	8.44
Carbon Dioxide	44.01	0.460	0.20	0.54	0.47	9.97
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**69.23**	**44.56**	**1282.94**
HAP SUBTOTAL		**1.73**	**1.49**	**3.96**	**1.77**	**73.46**
TOTAL		**100.0**	**37.63**	**100.0**	**102.39**	**1853.10**

Component	Uncontrolled Flashing Emissions (tons/yr)	Controlled Flashing Emissions (tons/yr)	Total Wellsite Flashing [a] (tons/yr)
Total VOC	0.00	64.15	64.15
Hazardous Air Pollutants [b]			
Benzene	0.00	0.20	0.20
Toluene	0.00	0.19	0.19
Ethylbenzene	0.00	0.010	0.01
Xylenes	0.00	0.060	0.06
n-Hexane	0.00	3.21	3.21
Greenhouse Gases [b]			
CO_2	0.00	9.97	9.97
CH_4	0.00	15.36	15.36
CO_2e	0.00	332.53	332.5

a Total wellsite flashing emissions are based on 0 uncontrolled tanks and 1450 tanks controlled at 95%.

22. Oil Truck Loadout

Assumptions:

Oil Well Production Rate	9.1	bbl/day-well
Number of Oil Wells not going to a GOSP	1450	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (°R)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [b]
Oil Loading [a]	0.6	2.8	50	520	2.01	9.1	0.14	203.70

	Oil Loading	
	tpy-well [c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.00045	0.65
Toluene	0.00041	0.60
Ethylbenzene	0.000023	0.033
Xylenes	0.00013	0.19
n-Hexane	0.0070	10.19
Greenhouse Gases		
CO2	0.00109	1.58
CH4	0.034	48.78
CO2e	0.71	1025.9

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5 at 60 °F.

b Assumes maximum development scenario

c Emissions estimated based on flashing analysis weight fractions

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23. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.055	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.00080	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.0052	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.0023	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.320

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Proposed Action	3,250	397.90	1,402.92	12.29	29,474

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

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24. Wellsite Pumping Unit Engines

Assumptions:

Pumpjack Engine power:	65.0	hp
Number of Wells Requiring Pumping Unit Engines:	3250	wells
Load Factor:	0.38	

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)} * \text{load factor}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [a] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/well)	Emissions (ton/yr-well)	Total Emissions [h] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [b]	-	1.89	0.10	0.45	1,465.02
CO [b]	-	2.58	0.14	0.62	1,999.87
VOC [a]	0.12	5.12E-01	0.028	0.12	396.60
PM_{10} [a,d]	4.83E-02	2.06E-01	0.011	0.049	159.67
$PM_{2.5}$ [a,d]	4.83E-02	2.06E-01	0.011	0.049	159.67
SO_2 [a]	5.88E-04	2.51E-03	0.00014	0.0006	1.94
Hazardous Air Pollutants [a]					
Benzene	1.94E-03	8.27E-03	0.00045	0.0020	6.41
Toluene	9.63E-04	4.11E-03	0.00022	0.0010	3.18
Ethylbenzene	1.08E-04	4.60E-04	0.000025	0.00011	0.36
Xylenes	2.68E-04	1.14E-03	0.000062	0.00027	0.89
Formaldehyde	5.52E-02	2.35E-01	0.013	0.056	182.44
Acetaldehyde	7.76E-03	3.31E-02	0.0018	0.0079	25.65
Acrolein	7.78E-03	3.32E-02	0.0018	0.0079	25.71
Benzo(a)pyrene/POM5	5.68E-09	2.42E-08	1.32E-09	0.00000001	0.000019
Biphenyl	3.95E-06	1.68E-05	0.0000009	0.0000040	0.013
Methanol	2.48E-03	1.06E-02	0.00058	0.0025	8.20
1,1,2,2-Tetrachloroethane	6.63E-05	2.83E-04	0.000015	0.000067	0.22
1,1,2-Trichloroethane	5.27E-05	2.25E-04	0.000012	0.000054	0.17
1,3-Dichloropropene	4.38E-05	1.87E-04	0.000010	0.000045	0.14
1,3-Butadiene	8.20E-04	3.50E-03	0.00019	0.00083	2.71
2,2,4-Trimethylpentane	8.46E-04	3.61E-03	0.00020	0.00086	2.80
Carbon Tetrachloride	6.07E-05	2.59E-04	0.000014	0.000062	0.20
Chlorobenzene	4.44E-05	1.89E-04	0.000010	0.000045	0.15
Chloroform	4.71E-05	2.01E-04	0.000011	0.000048	0.16
Chrysene/POM7	6.72E-07	2.87E-06	0.00000016	0.0000007	0.0022
Ethylene Dibromide	7.34E-05	3.13E-04	0.000017	0.000075	0.24
Methylene Chloride	1.47E-04	6.27E-04	0.000034	0.00015	0.49
n-Hexane	4.45E-04	1.90E-03	0.00010	0.00045	1.47
Naphthalene	9.63E-05	4.11E-04	0.000022	0.000098	0.32
Phenol	4.21E-05	1.80E-04	0.000010	0.000043	0.14
Styrene	5.48E-05	2.34E-04	0.000013	0.000056	0.18
Vinyl Chloride	2.47E-05	1.05E-04	0.0000057	0.000025	0.082
PAH	1.34E-04	5.71E-04	0.000031	0.00014	0.44
POM -2 [e]	3.28E-05	1.40E-04	0.0000076	0.000033	0.11
POM-6 [f]	3.50E-07	1.49E-06	0.00000008	0.0000004	0.0012
Greenhouse Gases					
CO_2 [g]	117	498	27.14	118.9	386,316
CH_4 [g]	0.002	0.01	0.00051	0.0022	7.29
N_2O [g]	0.0002	0.0009	0.000051	0.00022	0.73
CO_2e [i]	----	----	27.17	118.98	386,694

a AP-42 Table 3.2-1 Uncontrolled Emission Factors for 2-Stroke Lean-Burn Engines, 7/00
b Emission factors (g/hp-hr) from manufacturer specifications
c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9400 Btu/hp-hr
d PM = sum of PM filterable and PM condensable
e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, benzo(a)fluoranthene, benzo(e)pyrene, fluorene, phenanthrene, perylene, and pyrene.
f POM 6 includes: Benz(a)anthracene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.
h Estimated at full project production.
i Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

25. Production Heater Emissions

Assumptions

Oil Wellsite Separator Heater Size	500	Mbtu/hr
Oil Wellsite Tank Heater Size	250	Mbtu/hr per tank
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Oil wells with heater treaters	1450	wells
Oil well tanks	1,450	tanks
Load Factor	0.6	load rate

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Oil Well Separator Heater			Oil Well Tank Heaters			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Total Emissions (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.029	0.13	100	0.029	0.13	63.97	280.19
CO [a]	84	0.025	0.11	84	0.025	0.11	53.74	235.36
VOC [b]	5.5	0.0016	0.0071	5.5	0.0016	0.0071	3.52	15.41
SO_2 [b]	0.6	0.00018	0.00077	0.6	0.00018	0.00077	0.38	1.68
PM_{10} [b]	7.6	0.0022	0.0098	7.6	0.0022	0.0098	4.86	21.29
$PM_{2.5}$ [b]	7.6	0.0022	0.0098	7.6	0.0022	0.0098	4.86	21.29
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.18E-07	2.71E-06	2.10E-03	6.18E-07	2.71E-06	0.0013	0.0059
Toluene [c]	3.40E-03	1.00E-06	4.38E-06	3.40E-03	1.00E-06	4.38E-06	0.0022	0.010
Hexane [c]	1.80E+00	5.29E-04	2.32E-03	1.80E+00	5.29E-04	2.32E-03	1.15	5.04
Formaldehyde [c]	7.50E-02	2.21E-05	9.66E-05	7.50E-02	2.21E-05	9.66E-05	0.048	0.21
Dichlorobenzene [c]	1.20E-03	3.53E-07	1.55E-06	1.20E-03	3.53E-07	1.55E-06	0.00077	0.0034
Naphthalene [c]	6.10E-04	1.79E-07	7.86E-07	6.10E-04	1.79E-07	7.86E-07	0.00039	0.0017
POM 2[c,d,e]	5.90E-05	1.74E-08	7.60E-08	5.90E-05	1.74E-08	7.60E-08	0.000038	0.00017
POM 3[c,f]	1.60E-05	4.71E-09	2.06E-08	1.60E-05	4.71E-09	2.06E-08	0.000010	0.000045
POM 4[c,g]	1.80E-06	5.29E-10	2.32E-09	1.80E-06	5.29E-10	2.32E-09	0.000001	0.000005
POM 5[c,h]	2.40E-06	7.06E-10	3.09E-09	2.40E-06	7.06E-10	3.09E-09	0.000002	0.000007
POM 6[c,i]	7.20E-06	2.12E-09	9.28E-09	7.20E-06	2.12E-09	9.28E-09	0.000005	0.000020
POM 7[c,j]	1.8E-06	5.29E-10	2.32E-09	1.8E-06	5.29E-10	2.32E-09	0.000001	0.000005
Greenhouse Gases								
CO_2 [l]	119,226	35.07	153.59	119,226	35.07	153.59	76,269	334,060
CH_4 [l]	2.25	0.00066	0.0029	2.25	0.00066	0.0029	1.44	6.30
N_2O [l]	0.22	0.000066	0.00029	0.22	0.000066	0.00029	0.14	0.63
CO_2e [m]	---	35.10	153.74	---	35.10	153.74	76,344	334,387

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

26. Oil Well Fugitives

Number of Producting Wells 3250 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	5	8,760	0.19	4.50E-03	9.95E-03	0.042
Valves - Light Oil	7	8,760	0.69	2.50E-03	5.53E-03	0.117
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	7	8,760	0.69	9.80E-05	2.17E-04	0.0046
Connectors - Gas	7	8,760	0.19	2.00E-04	4.42E-04	0.0026
Connectors - Light Oil	11	8,760	0.69	2.10E-04	4.64E-04	0.015
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	11	8,760	0.69	1.10E-04	2.43E-04	0.0081
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	0	8,760	0.69	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	----
Flanges - Gas	8	8,760	0.19	3.90E-04	8.62E-04	0.0058
Flanges - Light Oil	12	8,760	0.69	1.10E-04	2.43E-04	0.0088
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	----
Flanges - Water/Lt. Oil	12	8,760	0.69	2.90E-06	6.41E-06	0.00023
Other - Gas	1	8,760	0.19	8.80E-03	1.94E-02	0.016
Other - Light Oil	1	8,760	0.69	7.50E-03	1.66E-02	0.050
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-well)						0.37
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**1198.00**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Table W-1C
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	3.31
Toluene Emissions	0.00011	0.0020	2.97
Ethylbenzene Emissions	----	0.00011	0.16
Xylene Emissions	0.000011	0.00065	0.92
n-Hexane Emissions	0.0035	0.035	52.55

26. Oil Well Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	19	8,760	0.84	0.0027	0.121	0.36	0.0031	7.51
Connectors - Gas	29	8,760	0.84	0.0027	0.017	0.08	0.0007	1.61
Open-Ended Lines - Gas	1	8,760	0.84	0.0027	0.031	0.005	0.00004	0.10
Flanges - Light Oil	32	8,760	0.84	0.0027	0.003	0.015	0.00013	0.31
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						0.59	0.0052	12.47
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**1929.15**	**16.88**	**40,529**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

27. Wellsite Flare Emissions

Assumptions:

Number of oil well pads with controls	725	well pads
Vent gas from each well pad	10.03	scf/hr-well pad
Average Heating Value of Combusted Gas	2100	Btu/scf
Average Heat Rating per Flare	0.02	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [c] (lb/hr)	Total Emissions [c] (tons/yr)
Criteria Pollutants					
NOx [a]	0.068	0.0014	0.006	1.04	4.55
CO [a]	0.37	0.008	0.034	5.65	24.75
Greenhouse Gases					
CO_2 [b]	---	2.69	11.78	1,949	8,539
CH_4 [b]	---	0.0083	0.036	5.98	26.21
N_2O [b]	---	0.000003	0.000012	0.0020	0.0086
CO_2e [b]	---	2.86	12.54	2,076	9,092

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

KLEINFELDER

Project: GMBU - Alternative D - Oil Wells

Date: 10/17/2014

28. Compressor Station Engines

Assumptions:

Number of new compressor stations	1	facilities
Number of expanded compressor stations	3	facilities
Compressor Engine Capacity	8000	hp

Equations:

Emission Factor (g/hp-hr) = average heat rate of 8,000 btu/hp-hr (8,000/1,000,000 *453.6 = 3.6288 multiplier)

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ g/lb} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions Per Facility (lb/hr-facility)	Emissions Per Facility (tons/yr-facility)	Emissions [i] Total (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	17.64	77.25	308.99
CO [a]	-	2.0	35.27	154.50	617.99
VOC [a]	-	0.7	12.35	54.07	216.30
PM_{10} [b,c]	9.95E-03	0.036	0.64	2.79	11.15
$PM_{2.5}$ [b,c]	9.95E-03	0.036	0.64	2.79	11.15
SO_2 [b]	5.88E-04	0.002	0.038	0.16	0.66
Hazardous Air Pollutants [b]					
Benzene	4.40E-04	1.60E-03	0.014	0.062	0.25
Toluene	4.08E-04	1.48E-03	0.013	0.057	0.23
Ethylbenzene	3.97E-05	1.44E-04	0.0013	0.0056	0.022
Xylenes	1.84E-04	6.68E-04	0.0059	0.026	0.10
n-Hexane	1.11E-03	4.03E-03	0.036	0.16	0.62
Formaldehyde	5.28E-02	1.92E-01	1.69	7.40	29.60
Acetaldehyde	8.36E-03	3.03E-02	0.27	1.17	4.69
Acrolein	5.14E-03	1.87E-02	0.16	0.72	2.88
Methanol	2.50E-03	9.07E-03	0.080	0.35	1.40
1,1,2,2-Tetrachloroethane	4.00E-05	1.45E-04	0.0013	0.0056	0.022
1,1,2-Trichloroethane	3.18E-05	1.15E-04	0.0010	0.0045	0.018
1,3-Dichloropropene	2.64E-05	9.58E-05	0.00084	0.0037	0.015
1,3-Butadiene	2.67E-04	9.69E-04	0.0085	0.037	0.15
2,2,4-Trimethylpentane	2.50E-04	9.07E-04	0.0080	0.035	0.14
Biphenyl	2.12E-04	7.69E-04	0.0068	0.030	0.12
Carbon Tetrachloride	3.67E-05	1.33E-04	0.0012	0.0051	0.021
Chlorobenzene	3.04E-05	1.10E-04	0.0010	0.0043	0.017
Chloroform	2.85E-05	1.03E-04	0.00091	0.0040	0.016
Ethylene Dibromide	4.43E-05	1.61E-04	0.0014	0.0062	0.025
Methylene Chloride	2.00E-05	7.26E-05	0.00064	0.0028	0.011
Naphthalene	7.44E-05	2.70E-04	0.0024	0.010	0.042
Phenol	2.40E-05	8.71E-05	0.00077	0.0034	0.013
Styrene	2.36E-05	8.56E-05	0.00076	0.0033	0.013
Tetrachloroethane	2.48E-06	9.00E-06	0.000079	0.00035	0.0014
Vinyl Chloride	1.49E-05	5.41E-05	0.00048	0.0021	0.0084
PAH -POM 1 [d,e]	2.69E-05	9.76E-05	0.00086	0.0038	0.015
POM 2 [d,f]	5.93E-05	2.15E-04	0.0019	0.0083	0.033
Benzo(b)fluoranthene/POM6	1.66E-07	6.02E-07	0.0000053	0.000023	0.000093
Chrysene/POM7	6.93E-07	2.51E-06	0.000022	0.00010	0.00039
Greenhouse Gases					
CO_2 [g]	117	424	7,481	32,766	131,064
CH_4 [g]	0.002	0.0080	0.14	0.62	2.47
N_2O [g]	0.0002	0.00080	0.014	0.062	0.25
CO_2e [h]	---	---	7,488	32,798	131,193

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00, with 50% control from catalyst for HAPs

c PM = sum of PM filterable and PM condensable

d Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP-42 Table 1.4-3 footnotes.

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

h Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

i Assumes maximum development scenario

KLEINFELDER

Project: GMBU - Alternative D - Oil Wells

Date: 10/17/2014

29. Compressor Station Condensate Tanks

Assumptions:

Average Condensate Production Rate :

Facility Production Rate	73.5	bbls per day per facility
Tank Control Efficiency	95	%
Total Facilities	4	Compressor Stations
Number of Tanks at Comp Station	4	tanks/facility

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0

Emission factors referenced from Gasco FEIS

Controlled by combustion device with 95% efficiency

Component	Tank Emissions (tons/yr/Tank)	Controlled Tank Emissions (tons/yr/Tank)	Total[a] Emissions (tons/yr)
Total VOC	6.52	0.33	5.21
Hazardous Air Pollutants			
Benzene	0.063	0.0032	0.051
Toluene	0.11	0.0053	0.085
Ethylbenzene	0.0046	0.00023	0.0037
Xylenes	0.038	0.0019	0.030
n-Hexane	0.17	0.0084	0.13
Greenhouse Gases			
CO_2	1.32	1.32	21.07
CH_4	6.24	0.31	4.99
CO_2e	132	7.87	125.92

a Assumes maximum development scenario

30. Compressor Station Dehydrator Emissions

Assumptions

Number of Compressor Stations 4 Stations
Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69	46.77
Hazardous Air Pollutants			
Benzene	0.13	0.56	2.24
Toluene	0.090	0.39	1.58
Ethylbenzene	---	---	---
Xylenes	0.016	0.070	0.28
n-Hexane	0.078	0.34	1.36
Greenhouse Gases			
CH_4	3.28	14.35	57.40
CO_2e	68.81	301.38	1205.50

a Assumes maximum development scenario

31. Compressor Station Fugitives

Number of Compressor Stations 4 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	114	8,760	0.19	4.50E-03	9.95E-03	0.95
Valves - Light Oil	28	8,760	0.41	2.50E-03	5.53E-03	0.28
Valves - Heavy Oil	0	8,760	0.41	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	28	8,760	0.41	9.80E-05	2.17E-04	0.011
Connectors - Gas	520	8,760	0.19	2.00E-04	4.42E-04	0.19
Connectors - Light Oil	44	8,760	0.41	2.10E-04	4.64E-04	0.04
Connectors - Heavy Oil	0	8,760	0.41	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	45	8,760	0.41	1.10E-04	2.43E-04	0.019
Open-Ended Lines - Gas	2	8,760	0.19	2.00E-03	4.42E-03	0.0074
Open-Ended Lines - Light Oil	0	8,760	0.41	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.41	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.41	2.50E-04	5.53E-04	---
Flanges - Gas	72	8,760	0.19	3.90E-04	8.62E-04	0.052
Flanges - Light Oil	0	8,760	0.41	1.10E-04	2.43E-04	---
Flanges - Heavy Oil	0	8,760	0.41	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	0	8,760	0.41	2.90E-06	6.41E-06	---
Other - Gas	91	8,760	0.19	8.80E-03	1.94E-02	1.48
Other - Light Oil	0	8,760	0.41	7.50E-03	1.66E-02	---
Other - Heavy Oil	0	8,760	0.41	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	0	8,760	0.41	1.40E-02	3.09E-02	---
Compressor station VOC Emissions (tons/yr)						**3.03**
Total Compressor station VOC Emissions (tons/yr)[d]						**12.10**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components referenced from similar existing facilities
b VOC and HAP weight fractions from wellsite gas analysis and compressor tank emissions
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Liquid Weight Fraction of VOCs	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.025
Toluene Emissions	0.0001	0.016	0.028
Ethylbenzene Emissions	----	0.00070	0.0010
Xylene Emissions	0.00001	0.0058	0.0085
n-Hexane Emissions	0.0035	0.026	0.23

31. Compressor Station Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	170	8,760	0.84	0.0027	0.121	3.20	0.028	67.17
Connectors - Gas	609	8,760	0.84	0.0027	0.017	1.61	0.014	33.81
Open-Ended Lines - Gas	2	8,760	0.84	0.0027	0.031	0.010	0.000084	0.20
Flanges - Light Oil	72	8,760	0.84	0.0027	0.003	0.034	0.00029	0.71
Other - Light Oil	91	8,760	0.84	0.0027	0.3	4.24	0.037	89.14
Compressor station GHG Emissions (tons/yr)						**9.09**	**0.080**	**191.0**
Total Compressor station GHG Emissions (tons/yr)[d]						**36.37**	**0.318**	**764.1**

a Number of components referenced from similar existing facilities
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

32. Compressor Station Truck Loadout

Assumptions:

Facility Production Rate 74 bbls per day per facility

Total Facilities 4

AP - 42, Chapter 5.2

$\mathbf{L_L = 12.46 \times S \times P \times M / T}$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility	tpy[b]
12.46	0.6	5.2	66	520	4.94	74	2.78	11.13

	tpy-facility[c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.027	0.11
Toluene	0.045	0.18
Ethylbenzene	0.0020	0.0078
Xylenes	0.016	0.064
n-Hexane	0.071	0.29
Greenhouse Gases		
CO2	0.56	2.25
CH4	2.66	10.65
CO2e	56.50	226.0

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60^{o}F.

b Emission for full buildout

c Emissions estimated based on condensate tank analysis

33. Compressor Station Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	10,260	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.15	0.27	6.05E-03	0.00	0.00	0.15	0.27
CO	1.02E-02	0.029	0.052	4.48E-02	0.00	0.00	0.029	0.052
VOC [c]	1.55E-03	0.0044	0.0080	1.61E-03	0.00	0.00	0.0044	0.0080
SO_2	3.07E-05	0.000086	0.00016	1.84E-05	0.0000	0.0000	0.000086	0.00016
PM_{10}	2.57E-03	0.0072	0.013	1.31E-04	0.000	0.000	0.0072	0.013
$PM_{2.5}$	2.50E-03	0.0070	0.013	1.21E-04	0.000	0.000	0.0070	0.013
Greenhouse Gases								
CO_2	4.520	12.7	23.2	1.050	0.0	0.0	12.7	23.2
CH_4	2.59E-05	0.00007	0.00013	9.38E-05	0.000	0.000	0.00007	0.00013
N_2O	4.01E-06	0.00001	0.00002	2.68E-05	0.0000	0.0000	0.00001	0.00002
CO_2e [c]	---	12.7	23.2	---	0.0	0.0	12.7	23.2

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

34. Compressor Station Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of Compressor Stations	4	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day All Facilities
Haul Trucks	45,000	1
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	1

	Emission Factor		Unpaved Road Emisions		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-facility**	**ton/year-facility**	**ton/year**
PM_{10}	1.72	1.51	0.80	1.28	5.13
$PM_{2.5}$	0.17	0.15	0.080	0.13	0.51

	Emission Factor		Paved Road Emisions		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-facility**	**ton/year-facility**	**ton/year**
PM_{10}	0.033	0.033	0.0051	0.0094	0.037
$PM_{2.5}$	0.0081	0.0081	0.0013	0.0023	0.0092

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

35 . Gas and Oil Separation Facility Generators

Assumptions:

Number of GOSPs	12	Facilities
Generator size	1,945	Horsepower
Number of Generators per GOSP	1	engines/Facility

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}*8760 \text{ (hr/yr)}}{453.6 \text{ (g/lb)}*2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (tons/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	4.29	18.78	225.37
CO [a]	-	2.0	8.58	37.56	450.75
VOC [a]	-	0.7	3.00	13.15	157.76
PM_{10} [b,d]	1.94E-02	7.92E-02	0.34	1.49	17.86
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.34	1.49	17.86
SO_2 [b]	5.88E-04	2.40E-03	0.010	0.045	0.54
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.014	0.061	0.73
Toluene	5.58E-04	2.28E-03	0.0049	0.021	0.26
Ethylbenzene	2.48E-05	1.01E-04	0.00022	0.0010	0.011
Xylenes	1.95E-04	7.96E-04	0.0017	0.0075	0.090
Formaldehyde	2.05E-02	8.37E-02	0.18	0.79	9.43
Acetaldehyde	2.79E-03	1.14E-02	0.024	0.11	1.28
Acrolein	2.63E-03	1.07E-02	0.023	0.10	1.21
Methanol	3.06E-03	1.25E-02	0.027	0.12	1.41
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.00022	0.0010	0.012
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.00013	0.00059	0.0070
1,3-Dichloropropene	1.27E-05	5.18E-05	0.00011	0.00049	0.0058
1,3-Butadiene	6.63E-04	2.71E-03	0.0058	0.025	0.30
Carbon Tetrachloride	1.77E-05	7.23E-05	0.00015	0.00068	0.0081
Chlorobenzene	1.29E-05	5.27E-05	0.00011	0.00049	0.0059
Chloroform	1.37E-05	5.59E-05	0.00012	0.00053	0.0063
Ethylene Dibromide	2.13E-05	8.70E-05	0.00019	0.00082	0.010
Methylene Chloride	4.12E-05	1.68E-04	0.00036	0.0016	0.019
Naphthalene	9.71E-05	3.96E-04	0.00085	0.0037	0.045
Styrene	1.19E-05	4.86E-05	0.00010	0.00046	0.0055
Vinyl Chloride	7.18E-06	2.93E-05	0.00006	0.00028	0.0033
PAH -POM 1	1.41E-04	5.76E-04	0.0012	0.0054	0.065
Greenhouse Gases					
CO_2 [e]	117	477.2	2046	8,962	107,542
CH_4 [e]	0.002	0.0090	0.0386	0.17	2.03
N_2O [e]	0.0002	0.00090	0.00386	0.02	0.20
CO_2e [f]	---	---	2048	2048.08	107647

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

36. GOSP Truck Loadout

Assumptions:

Facility Production Rate	5,000	bbls oil per day per facility
Total Facilities	12	central tank batteries
Control Efficiency	95	%

AP - 42, Chapter 5.2

L_L = 12.46 x S x P x M / T

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility[d]	tpy[b,d]
12.46	0.6	2.8	50	520	2.01	5000	3.86	46.31

	tpy-facility[c,d]	tpy[b,c,d]
Hazardous Air Pollutants		
Benzene	0.012	0.15
Toluene	0.011	0.14
Ethylbenzene	0.00063	0.0075
Xylenes	0.0036	0.043
n-Hexane	0.19	2.32
Greenhouse Gases		
CO2	0.030	0.36
CH4	0.92	11.09
CO2e	19.44	233.24

Notes:

a Vapor molecular weight and True Vapor Pressure (TVP) of the loaded liquid from AP-42 Chapter 7, Table 7.1-2, assuming the properties of Crude Oil RVP 5.

b Emission for full buildout

c Emissions estimated based on oil flashing analysis

d Emissions controlled by 95%

37. GOSP Fugitives

Number of GOSP Facilities 12 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	372	8,760	0.19	4.50E-03	9.95E-03	3.10
Valves - Light Oil	390	8,760	0.69	2.50E-03	5.53E-03	6.53
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	74	8,760	0.69	9.80E-05	2.17E-04	0.049
Connectors - Gas	89	8,760	0.19	2.00E-04	4.42E-04	0.033
Connectors - Light Oil	66	8,760	0.69	2.10E-04	4.64E-04	0.09
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	22	8,760	0.69	1.10E-04	2.43E-04	0.02
Open-Ended Lines - Gas	17	8,760	0.19	2.00E-03	4.42E-03	0.0629
Open-Ended Lines - Light Oil	2	8,760	0.69	1.40E-03	3.09E-03	0.0188
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.69	2.50E-04	5.53E-04	---
Flanges - Gas	602	8,760	0.19	3.90E-04	8.62E-04	0.434
Flanges - Light Oil	1142	8,760	0.69	1.10E-04	2.43E-04	0.842
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	213	8,760	0.69	2.90E-06	6.41E-06	0.00414
Other - Gas	8	8,760	0.19	8.80E-03	1.94E-02	0.130
Other - Light Oil	4	8,760	0.69	7.50E-03	1.66E-02	0.201
Other - Heavy Oil	0	8,760	0.69	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	1	8,760	0.69	1.40E-02	3.09E-02	0.094
VOC EMISSIONS (tons/yr-facility)						11.61
TOTAL CTB VOC EMISSIONS (tons/yr)[d]						**139.32**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.35
Toluene Emissions	0.00011	0.0020	0.30
Ethylbenzene Emissions	----	0.00011	0.015
Xylene Emissions	0.000011	0.00065	0.091
n-Hexane Emissions	0.0035	0.035	5.55

37. GOSP Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	836	8,760	0.84	0.0027	0.121	15.72	0.138	330.31
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.004	9.83
Open-Ended Lines - Gas	19	8,760	0.84	0.0027	0.031	0.092	0.00080	1.92
Flanges - Light Oil	1957	8,760	0.84	0.0027	0.003	0.913	0.00798	19.17
Other - Light Oil	13	8,760	0.84	0.0027	0.3	0.61	0.0053	12.73
EMISSIONS (tons/yr-facility)						17.80	0.156	373.97
TOTAL CTB GHG EMISSIONS (tons/yr)[d]						**213.61**	**1.87**	**4487.60**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

38. GOSP Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	571,656	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [d]	
Vehicles	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	8.39	15.32	6.05E-03	0.00	0.00	8.39	15.32
CO	1.02E-02	1.60	2.92	4.48E-02	0.00	0.00	1.60	2.92
VOC [c]	1.55E-03	0.24	0.44	1.61E-03	0.00	0.00	0.24	0.44
SO_2	3.07E-05	0.005	0.009	1.84E-05	0.0000	0.0000	0.005	0.009
PM_{10}	2.57E-03	0.40	0.73	1.31E-04	0.000	0.000	0.40	0.73
$PM_{2.5}$	2.50E-03	0.39	0.71	1.21E-04	0.000	0.000	0.39	0.71
Greenhouse Gases								
CO_2	4.520	707.9	1,291.9	1.050	0.0	0.0	707.9	1,291.9
CH_4	2.59E-05	0.0041	0.007	9.38E-05	0.000	0.000	0.004	0.007
N_2O	4.01E-06	0.0006	0.0011	2.68E-05	0.0000	0.0000	0.0006	0.0011
CO_2e [c]	---	708.2	1,292.5	---	0.0	0.0	708.2	1292.5

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

39. GOSP Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of GOSP Facilities	12	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day All Facilities
Haul Trucks	45,000	63
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	63

	Emission Factor		Unpaved Road Emisions		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-facility**	**ton/year-facility**	**ton/year**
PM_{10}	1.72	1.51	16.85	26.95	323.44
$PM_{2.5}$	0.17	0.15	1.685	2.695	32.34

	Emission Factor		Paved Road Emisions		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr-facility**	**ton/year-facility**	**ton/year**
PM_{10}	0.033	0.033	0.11	0.20	2.36
$PM_{2.5}$	0.0081	0.0081	0.026	0.048	0.58

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

KLEINFELDER	Project: GMBU - Alternative D - Oil Wells Date: 10/17/2014

40. Water Treatment Facility Oil Storage Tank Working/Breathing Emissions

Assumptions:

Average Oil Production Rate :

Facility Production Rate	160	bbls oil per day per facility
Total Facilities	13	water treatment facilities
No. Tanks at each facility	6	Tanks per facility
Throughput	2,452,800	gallons per year per facility
Throughput	408,800	gallons per year per tank

Calculations:

Oil tank working/breathing emissions estimated with Tanks 4.09d

Component	Tank Work / Breathing (tons/yr/tank)	Tank Work / Breathing (tons/yr/facility)	Total[a] Emissions (tons/yr)
Total VOC	1.02	6.097	79.25
Hazardous Air Pollutants			
Benzene	0.0032	0.019	0.25
Toluene	0.0030	0.018	0.23
Ethylbenzene	0.00017	0.00099	0.013
Xylenes	0.0010	0.0057	0.074
n-Hexane	0.051	0.31	3.97
Greenhouse Gases			
CO_2	0.0079	0.047	0.62
CH_4	0.24	1.46	18.98
CO_2e	5.12	30.70	399.14

a Emissions for full buildout

b HAPs and Greenhouse Gas Emissions scaled from oil flashing VOC and HAP/GHG weight fractions.

Project: GMBU - Alternative D - Oil Wells

Date: 10/17/2014

41. Water Treatment Facility Oil Storage Tank Flashing Emissions

Vent Rate =	**1241.60 scf/day-facility**

* Gas to oil ratio * production per facility

Flashing Emissions per tank

COMPONENT	COMPONENT MOLE WEIGHT (lb/lb-mol)	MOLE PERCENT	NET MOLE WEIGHT (lb/lb-mol)	WEIGHT FRACTION	COMPONENT FLOW RATE (scf/day)	COMPONENT FLOW RATE (tons/yr)
Methane	16.04	38.894	6.24	0.166	482.91	3.73
Ethane	30.07	16.516	4.97	0.132	205.06	2.97
Propane	44.10	16.909	7.46	0.198	209.94	4.45
i-Butane	58.12	3.694	2.15	0.057	45.86	1.28
n-Butane	58.12	9.044	5.26	0.140	112.29	3.14
i-Pentane	72.15	3.269	2.36	0.063	40.59	1.41
n-Pentane	72.15	4.297	3.10	0.082	53.35	1.85
Cyclopentane	70.10	0.361	0.25	0.0067	4.48	0.151
Hexanes	86.18	2.285	1.97	0.052	28.37	1.18
Heptanes	100.20	1.423	1.43	0.038	17.67	0.85
Octanes	114.23	0.403	0.46	0.012	5.00	0.275
Nonanes	128.26	0.076	0.10	0.0026	0.94	0.0582
Decanes +	142.29	0.026	0.037	0.0010	0.323	0.0221
Benzene	78.11	0.106	0.083	0.0022	1.32	0.0494
Toluene	92.14	0.083	0.076	0.0020	1.03	0.0457
Ethylbenzene	106.17	0.004	0.0042	0.00011	0.0497	0.00254
Xylenes	106.17	0.023	0.024	0.00065	0.286	0.0146
n-Hexane	86.18	1.513	1.30	0.035	18.79	0.779
Nitrogen	28.01	0.612	0.17	0.0046	7.60	0.102
Carbon Dioxide	44.01	0.460	0.20	0.0054	5.71	0.121
Hydrogen Sulfide	34.08	---	---	---	---	---
VOC SUBTOTAL		**43.52**	**26.05**	**0.692**	**540.29**	**15.56**
HAP SUBTOTAL		**1.73**	**1.49**	**0.040**	**21.47**	**0.89**
TOTAL		**100.00**	**37.63**	**1.000**	**1241.58**	**22.47**

Number of Water Treatment Facilities	**13**

Total Flashing Emissions for All Tanks (tons/yr)

VOC	202.24
Hazardous Air Pollutants	
Benzene	0.64
Toluene	0.59
Ethylbenzene	0.033
Xylenes	0.19
n-Hexane	10.12
HAPs	11.58
Greenhouse Gases	
CO2	1.57
CH4	48.43
CO2e	1018.5

42. Water Treatment Facility Fugitives

Number Water Treatment Facilities 13 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	19	8,760	0.19	4.50E-03	9.95E-03	0.16
Valves - Light Oil	29	8,760	0.69	2.50E-03	5.53E-03	0.49
Valves - Heavy Oil	0	8,760	0.69	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	29	8,760	0.69	9.80E-05	2.17E-04	0.019
Connectors - Gas	66	8,760	0.19	2.00E-04	4.42E-04	0.024
Connectors - Light Oil	99	8,760	0.69	2.10E-04	4.64E-04	0.14
Connectors - Heavy Oil	0	8,760	0.69	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	99	8,760	0.69	1.10E-04	2.43E-04	0.073
Open-Ended Lines - Gas	1	8,760	0.19	2.00E-03	4.42E-03	0.0037
Open-Ended Lines - Light Oil	1	8,760	0.69	1.40E-03	3.09E-03	0.0094
Open-Ended Lines - Heavy Oil	0	8,760	0.69	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	1	8,760	0.69	2.50E-04	5.53E-04	0.0017
Flanges - Gas	3	8,760	0.19	3.90E-04	8.62E-04	0.0022
Flanges - Light Oil	5	8,760	0.69	1.10E-04	2.43E-04	0.0037
Flanges - Heavy Oil	0	8,760	0.69	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	5	8,760	0.69	2.90E-06	6.41E-06	0.00010
VOC EMISSIONS (tons/yr-facility)						0.92
TOTAL Water Treatment VOC EMISSIONS (tons/yr)[d]						**11.97**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Oil Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.0022	0.033
Toluene Emissions	0.00011	0.0020	0.029
Ethylbenzene Emissions	----	0.00011	0.0016
Xylene Emissions	0.000011	0.00065	0.0091
n-Hexane Emissions	0.0035	0.0346	0.52

42. Water Treatment Facility Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	77	8,760	0.84	0.0027	0.121	1.45	0.013	30.42
Connectors - Gas	264	8,760	0.84	0.0027	0.017	0.70	0.0061	14.65
Open-Ended Lines - Gas	3	8,760	0.84	0.0027	0.031	0.014	0.00013	0.30
Flanges - Light Oil	13	8,760	0.84	0.0027	0.003	0.0061	0.000053	0.13
EMISSIONS (tons/yr-facility)						2.17	0.019	45.51
TOTAL Water Treatment GHG EMISSIONS (tons/yr)[d]						**28.16**	**0.25**	**591.6**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

KLEINFELDER Bright People. Right Solutions.	Project: GMBU - Alternative D - Oil Wells Date: 10/17/2014

43. Water Treatment Plant Generator

Assumptions:

Number of facilities	13	
Generator horsepower	1,945	hp/engine

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}*8760\ \text{(hr/yr)}}{453.6\ \text{(g/lb)}*2000\ \text{(lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (ton/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	4.29	18.78	244.15
CO [a]	-	2.0	8.58	37.56	488.31
VOC [a]	-	0.7	3.00	13.15	170.91
PM_{10} [b,d]	1.94E-02	7.92E-02	0.340	1.49	19.35
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.340	1.49	19.35
SO_2 [b]	5.88E-04	2.40E-03	0.0103	0.045	0.586
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.014	0.061	0.79
Toluene	5.58E-04	2.28E-03	0.0049	0.021	0.28
Ethylbenzene	2.48E-05	1.01E-04	0.00022	0.0010	0.012
Xylenes	1.95E-04	7.96E-04	0.0017	0.0075	0.097
Formaldehyde	2.05E-02	8.37E-02	0.18	0.79	10.22
Acetaldehyde	2.79E-03	1.14E-02	0.024	0.11	1.39
Acrolein	2.63E-03	1.07E-02	0.023	0.10	1.31
Methanol	3.06E-03	1.25E-02	0.027	0.12	1.52
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.00022	0.0010	0.013
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.00013	0.00059	0.0076
1,3-Dichloropropene	1.27E-05	5.18E-05	0.00011	0.00049	0.0063
1,3-Butadiene	6.63E-04	2.71E-03	0.0058	0.025	0.33
Carbon Tetrachloride	1.77E-05	7.23E-05	0.00015	0.00068	0.0088
Chlorobenzene	1.29E-05	5.27E-05	0.00011	0.00049	0.0064
Chloroform	1.37E-05	5.59E-05	0.00012	0.00053	0.0068
Ethylene Dibromide	2.13E-05	8.70E-05	0.00019	0.00082	0.011
Methylene Chloride	4.12E-05	1.68E-04	0.00036	0.0016	0.021
Naphthalene	9.71E-05	3.96E-04	0.00085	0.0037	0.048
Styrene	1.19E-05	4.86E-05	0.00010	0.00046	0.0059
Vinyl Chloride	7.18E-06	2.93E-05	0.000063	0.00028	0.0036
PAH -POM 1	1.41E-04	5.76E-04	0.0012	0.0054	0.070
Greenhouse Gases					
CO_2 [e]	117	477.2	2,046	8,962	116,504
CH_4 [e]	0.002	9.00E-03	0.0386	0.17	2.20
N_2O [e]	0.0002	9.00E-04	0.00386	0.017	0.22
CO_2e [f]	---	---	2,048	8,971	116,618

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

44. Central Facility Heater Emissions

Assumptions

GOSP Heater Size	11	MMbtu/hr
Number of Heaters at each GOSP	3	heaters
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Development size	12	GOSP Facilities
	4	Compressor Stations

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	GOSP Heater Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr-facility)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	3.24	14.17	100	0.147	0.64	39.41	172.62
CO [a]	84	2.72	11.90	84	0.124	0.54	33.11	145.00
VOC [b]	5.5	0.18	0.78	5.5	0.008	0.04	2.17	9.49
SO_2 [b]	0.6	0.019	0.085	0.6	0.001	0.00	0.24	1.04
PM_{10} [b]	7.6	0.25	1.08	7.6	0.011	0.05	3.00	13.12
$PM_{2.5}$ [b]	7.6	0.25	1.08	7.6	0.011	0.05	3.00	13.12
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	6.79E-05	2.98E-04	2.10E-03	3.09E-06	1.35E-05	8.28E-04	0.0036
Toluene [c]	3.40E-03	1.10E-04	4.82E-04	3.40E-03	5.00E-06	2.19E-05	1.34E-03	0.0059
Hexane [c]	1.80E+00	5.82E-02	2.55E-01	1.80E+00	2.65E-03	1.16E-02	7.09E-01	3.11
Formaldehyde [c]	7.50E-02	2.43E-03	1.06E-02	7.50E-02	1.10E-04	4.83E-04	2.96E-02	0.13
Dichlorobenzene [c]	1.2E-03	3.88E-05	1.70E-04	1.2E-03	1.76E-06	7.73E-06	4.73E-04	0.0021
Naphthalene [c]	6.1E-04	1.97E-05	8.64E-05	6.1E-04	8.97E-07	3.93E-06	2.40E-04	0.0011
POM 2 [c,d,e]	5.9E-05	1.91E-06	8.36E-06	5.9E-05	8.68E-08	3.80E-07	2.33E-05	0.00010
POM 3 [c,f]	1.6E-05	5.18E-07	2.27E-06	1.6E-05	2.35E-08	1.03E-07	6.31E-06	0.000028
POM 4 [c,g]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	7.09E-07	0.0000031
POM 5 [c,h]	2.4E-06	7.76E-08	3.40E-07	2.4E-06	3.53E-09	1.55E-08	9.46E-07	0.0000041
POM 6 [c,i]	7.2E-06	2.33E-07	1.02E-06	7.2E-06	1.06E-08	4.64E-08	2.84E-06	0.000012
POM 7 [c,j]	1.8E-06	5.82E-08	2.55E-07	1.8E-06	2.65E-09	1.16E-08	7.09E-07	0.0000031
Greenhouse Gases								
CO_2 [l]	119,226	3857.30	16894.98	119,226	175.3	767.95	46988.9	205812
CH_4 [l]	2.25	0.073	0.32	2.25	0.0033	0.014	0.89	3.88
N_2O [l]	0.22	0.0073	0.03	0.22	0.00033	0.0014	0.089	0.39
CO_2e [m]	---	3861.1	16911.5	---	175.50	768.71	47035	206013

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98
b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)
c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98
d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html
e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.
f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.
g POM 4 includes: 3-Methylchloranthrene.
h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.
i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.
j POM 7 includes: Chrysene.
k Assumes maximum development scenario
l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.
m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

45. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations 4
Number of GOSPs 12

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-facility)	Total Emissions (tons/yr-facility)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	14.30
CO [a]	0.37	1.11	4.86	77.79
Greenhouse Gases				
CO2 [b]	---	508	2,227	35,625
CH4 [b]	---	3.25	14.22	227.52
N2O [b]	---	0.0007	0.003	0.05
CO2e [b]	---	577	2,526	40,418

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

50 MMscfd

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

---

50 MMscfd

Calculated Absorber Stages:	2.51
Specified Dry Gas Dew Point:	5.00 lbs. H2O/MMSCF
Temperature:	125.0 deg. F
Pressure:	800.0 psig
Dry Gas Flow Rate:	50.0000 MMSCF/day
Glycol Losses with Dry Gas:	1.8232 lb/hr
Wet Gas Water Content:	Saturated
Calculated Wet Gas Water Content:	137.42 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

	50 MMscfd	
2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

50 MMscfd

Flow Rate: 1.46e+001 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

	50 MMscfd	
Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification	
User Identification:	GMBU Water treatment tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 500 bbl Storage Tank
Tank Dimensions	
Shell Height (ft):	25.00
Diameter (ft):	12.00
Liquid Height (ft) :	24.00
Avg. Liquid Height (ft):	12.00
Volume (gallons):	20,304.71
Turnovers:	20.13
Net Throughput(gal/yr):	408,800.00
Is Tank Heated (y/n):	N
Paint Characteristics	
Shell Color/Shade:	Gray/Light
Shell Condition	Good
Roof Color/Shade:	Gray/Light
Roof Condition:	Good
Roof Characteristics	
Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00
Breather Vent Settings	
Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations	
Standing Losses (lb):	962.6416
Vapor Space Volume (cu ft):	1,527.3376
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3229
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,527.3376
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	13.5046
Tank Shell Height (ft):	25.0000
Average Liquid Height (ft):	12.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3229
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	13.5046

Working Losses (lb):	1,069.5271
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	408,800.0000
Annual Turnovers:	20.1333
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	20,304.7110
Maximum Liquid Height (ft):	24.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	2,032.1687

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMBU Water treatment tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	1,069.53	962.64	2,032.17

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification	
User Identification:	GMBU Alt D Oil Well Tanks
City:	Duchesne
State:	Utah
Company:	Newfield Exploration
Type of Tank:	Vertical Fixed Roof Tank
Description:	One (1) 400 bbl Storage Tank
Tank Dimensions	
Shell Height (ft):	20.00
Diameter (ft):	12.00
Liquid Height (ft) :	19.00
Avg. Liquid Height (ft):	10.00
Volume (gallons):	16,074.56
Turnovers:	8.68
Net Throughput(gal/yr):	139,503.00
Is Tank Heated (y/n):	N
Paint Characteristics	
Shell Color/Shade:	Gray/Light
Shell Condition	Good
Roof Color/Shade:	Gray/Light
Roof Condition:	Good
Roof Characteristics	
Type:	Dome
Height (ft)	1.00
Radius (ft) (Dome Roof)	12.00
Breather Vent Settings	
Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Grand Junction, Colorado (Avg Atmospheric Pressure = 12.37 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

GMBU Alt D Oil Well Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Crude oil (RVP 5)	All	60.92	50.34	71.50	55.17	2.9302	2.3720	3.5895	50.0000			207.00	Option 4: RVP=5

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

GMBU Alt D Oil Well Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

Annual Emission Calcaulations	
Standing Losses (lb):	881.3736
Vapor Space Volume (cu ft):	1,188.0456
Vapor Density (lb/cu ft):	0.0262
Vapor Space Expansion Factor:	0.2039
Vented Vapor Saturation Factor:	0.3800
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	1,188.0456
Tank Diameter (ft):	12.0000
Vapor Space Outage (ft):	10.5046
Tank Shell Height (ft):	20.0000
Average Liquid Height (ft):	10.0000
Roof Outage (ft):	0.5046
Roof Outage (Dome Roof)	
Roof Outage (ft):	0.5046
Dome Radius (ft):	12.0000
Shell Radius (ft):	6.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0262
Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Daily Avg. Liquid Surface Temp. (deg. R):	520.5908
Daily Average Ambient Temp. (deg. F):	52.9333
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	514.8433
Tank Paint Solar Absorptance (Shell):	0.5400
Tank Paint Solar Absorptance (Roof):	0.5400
Daily Total Solar Insulation Factor (Btu/sqft day):	1,578.3125
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2039
Daily Vapor Temperature Range (deg. R):	42.3201
Daily Vapor Pressure Range (psia):	1.2175
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	2.3720
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	3.5895
Daily Avg. Liquid Surface Temp. (deg R):	520.5908
Daily Min. Liquid Surface Temp. (deg R):	510.0108
Daily Max. Liquid Surface Temp. (deg R):	531.1708
Daily Ambient Temp. Range (deg. R):	25.6333
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.3800
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	2.9302
Vapor Space Outage (ft):	10.5046
Working Losses (lb):	364.9761

Vapor Molecular Weight (lb/lb-mole):	50.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	2.9302
Annual Net Throughput (gal/yr.):	139,503.0000
Annual Turnovers:	8.6785
Turnover Factor:	1.0000
Maximum Liquid Volume (gal):	16,074.5628
Maximum Liquid Height (ft):	19.0000
Tank Diameter (ft):	12.0000
Working Loss Product Factor:	0.7500
Total Losses (lb):	1,246.3498

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

GMBU Alt D Oil Well Tanks - Vertical Fixed Roof Tank
Duchesne, Utah

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Crude oil (RVP 5)	364.98	881.37	1,246.35

APPENDIX E-2

RESOURCE PROTECTION ALTERNATIVE GAS WELL EMISSIONS

KLEINFELDER Bright People. Right Solutions.	Project: GMBU - Alternative D -Gas Wells Date: 10/17/2014

Greater Monument Butte Unit Annual Emissions Summary (tons/yr) - Alternative D - Gas Wells [a]

		Criteria Pollutant Emissions					
	Source ID	**NO_X**	**CO**	**VOC**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**
Development Emissions	Construction	2.1	0.8	0.2	0.0001	2.8	0.5
	Drilling	577.7	562.5	31.3	1.2	725.4	80.7
	Completion	67.4	22.8	2.6	0.039	384.7	41.1
	Interim Reclamation	0.2	0.2	0.01	0.0001	3.5	0.4
	Wind Erosion	---	---	---	---	0.6	0.1
Wellsite Production Emissions	Production Heaters	483.1	405.8	26.6	2.9	36.7	36.7
	Wellsite Tanks	---	---	1,773.5	---	---	---
	Pneumatics	---	---	306.1	---	---	---
	Fugitives	---	---	1,452.7	---	---	---
	Wellsite Truck Loading	---	---	189.2	---	---	---
	Wellsite Dehydrators	---	---	47.3	---	---	---
	Wellsite Flares	20.1	109.3	---	---	---	---
	Operations Vehicle	7.9	8.0	0.4	0.007	246.2	25.1
Gas Processing Plant Emissions	Gas Plant Compressor Engines	11.6	23.2	8.1	0.03	0.9	0.9
	Gas Plant Flares	0.9	4.9	---	---	---	---
	Gas Plant Fugitives	---	---	0.8	---	---	---
	Gas Plant Dehydrator Heater	0.6	0.5	0.04	0.004	0.05	0.05
	Gas Plant Dehydrator	---	---	11.7	---	---	---
Compressor Station Emissions	Compressor Station Engines	1,545.0	3,089.9	1,081.5	3.3	55.8	55.8
	Compressor Station Tanks	---	---	26.1	---	---	---
	Compressor Station Dehydrator	---	---	233.8	---	---	---
	Compressor Station Truck Loading and Vehicle Traffic	1.4	0.3	55.7	0.0	31.1	3.2
	Compressor Station Dehydrator Heater	12.9	10.8	0.7	0.1	1.0	1.0
	Compressor Station Flare	17.9	97.2	---	---	---	---
	Compressor Station Fugitives	---	---	60.5	---	---	---
	Total Emissions	**2,748.7**	**4,336.2**	**5,308.8**	**7.5**	**1,488.8**	**245.5**

a Emissions in summary tables may vary slightly due to rounding differences.

Development Emissions Summary

Pollutant	Development Emissions (tons/year) [a,b]					Total
	Construction	Drilling[c]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
Criteria Pollutants & VOC						
NO_X	2.1	577.7	67.4	0.2	---	647.4
CO	0.8	562.5	22.8	0.2	---	586.3
VOC	0.2	31.3	2.6	0.01	---	34.1
SO_2	0.0001	1.2	0.04	0.0001	---	1.2
PM_{10}	2.8	725.4	384.7	3.5	0.6	1117.0
$PM_{2.5}$	0.5	80.7	41.1	0.4	0.1	122.7
Hazardous Air Pollutants						
Benzene	---	0.51	0.010	---	---	0.52
Toluene	---	0.18	0.004	---	---	0.19
Ethylbenzene	---	---	---	---	---	---
Xylene	---	0.13	0.0026	---	---	0.13
n-Hexane	---	---	---	---	---	---
Formaldehyde	---	0.052	0.0011	---	---	0.053
Acetaldehyde	---	0.017	0.00034	---	---	0.017
Acrolein	---	0.0052	0.00011	---	---	0.0053
Naphthalene	---	0.085	0.0017	---	---	0.087
POM 2	---	0.050	0.0010	---	---	0.051
POM 5	---	0.00040	0.000008	---	---	0.00040
POM 6	---	0.0015	0.000032	---	---	0.0016
POM 7	---	0.0010	0.000021	---	---	0.0010
Greenhouses Gases						
CO_2	55.3	110,750	5,555	16	---	116,376
CH_4	0.0005	4.41	0.18	0.00053	---	4.59
N_2O	0.0002	0.89	0.04	0.00018	---	0.93
CO_2e	55.3	111,118	5,571	16	---	116,760

a Assumes maximum development scenario of 156 wells in one year
b Emissions in summary tables may vary slightly due to rounding differences.
c Total drilling emissions includes Tier IV drill rig engines

Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a,b]								
	Well Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Pneumatics	Wellsite Flares	Wellsite Dehydrators	Operations Vehicle	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	483.1	---	---	---	---	20.1	---	7.9	511.1
CO	405.8	---	---	---	---	109.3	---	8.0	523.1
VOC	26.6	1773.5	1452.7	189.2	306.1	---	47.3	0.4	3,795.8
SO_2	2.9	---	---	---	---	---	---	0.007	2.9
PM_{10}	36.7	---	---	---	---	---	---	246.2	283.0
$PM_{2.5}$	36.7	---	---	---	---	---	---	25.1	61.8
Hazardous Air Pollutants									
Benzene	0.010	17.25	3.97	1.84	0.33	---	2.75	---	26.15
Toluene	0.016	28.75	5.20	3.07	0.17	---	11.64	---	48.84
Ethylbenzene	---	1.25	0.20	0.13	---	---	3.41	---	4.99
Xylene	---	10.25	1.69	1.09	0.017	---	24.25	---	37.30
n-Hexane	8.70	45.50	28.85	4.85	5.65	---	---	---	93.56
Formaldehyde	0.36	---	---	---	---	---	---	---	0.36
Dichlorobenzene	0.0058	---	---	---	---	---	---	---	0.0058
Naphthalene	0.0029	---	---	---	---	---	---	---	0.0029
POM 2	0.00029	---	---	---	---	---	---	---	0.00029
POM 3	0.000077	---	---	---	---	---	---	---	0.000077
POM 4	0.0000087	---	---	---	---	---	---	---	0.0000087
POM 5	0.000012	---	---	---	---	---	---	---	0.000012
POM 6	0.000035	---	---	---	---	---	---	---	0.000035
POM 7	0.0000087	---	---	---	---	---	---	---	0.000009
Greenhouse Gases									
CO_2	575,965	358.3	33.9	38.2	9.5	24,974.9	---	746.9	602,127
CH_4	10.86	1698.3	3871.0	181.19	1,079.17	238.0	73.98	0.0173	7,152
N_2O	1.09	---	---	---	---	0.0	---	0.0045	1.13
CO_2e	576,530	36,022	81,324	3,843	22,672	29,986	1,553	749	752,679

a Assumes maximum development scenario of 2500 gas wells

b Emissions in summary tables may vary slightly due to rounding differences.

Project: GMBU - Alternative D -Gas Wells

Date: 10/17/2014

Total Project Infrastructure Related Emissions Summary

Pollutant	Total Project Infrastructure Related Emissions (tons/year) [a,b]								
	Production Heaters	Stock Tanks	Fugitive Emissions	Truck Loading	Central Facility Flares	Dehydrators	Compressor Engines	Vehicle Traffic	Total (tons/year)
Criteria Pollutants & VOC									
NO_X	13.5	---	---	---	18.8	---	1556.6	1.4	1,590.2
CO	11.4	---	---	---	102.1	---	3113.1	0.3	3,226.8
VOC	0.7	26.1	61.4	55.6	---	245.5	1089.6	0.04	1,479.0
SO_2	0.08	---	---	---	---	---	3.3	0.0008	3.4
PM_{10}	1.0	---	---	---	---	---	56.7	31.1	88.8
$PM_{2.5}$	1.0	---	---	---	---	---	56.7	3.2	60.9
Hazardous Air Pollutants									
Benzene	0.00028	0.254	0.125	0.54	---	11.76	1.27	---	13.95
Toluene	0.00046	0.423	0.142	0.90	---	8.27	1.16	---	10.89
Ethylbenzene	---	0.0184	0.0049	0.0392	---	---	0.11	---	0.17
Xylene	---	0.151	0.043	0.322	---	1.48	0.52	---	2.51
n-Hexane	0.24	0.67	1.18	1.43	---	7.13	3.11	---	13.77
Formaldehyde	0.010	---	---	---	---	---	148.49	---	148.50
Acetaldehyde	---	---	---	---	---	---	23.50	---	23.50
Acrolein	---	---	---	---	---	---	14.47	---	14.47
Methanol	---	---	---	---	---	---	7.08	---	7.08
1,1,2,2-Tetrachloroethane	---	---	---	---	---	---	0.11	---	0.11
1,1,2-Trichloroethane	---	---	---	---	---	---	0.090	---	0.090
1,3-Dichloropropene	---	---	---	---	---	---	0.074	---	0.074
1,3-Butadiene	---	---	---	---	---	---	0.76	---	0.76
2,2,4-Trimethylpentane	---	---	---	---	---	---	0.70	---	0.70
Biphenyl	---	---	---	---	---	---	0.59	---	0.59
Carbon Tetrachloride	---	---	---	---	---	---	0.10	---	0.10
Chlorobenzene	---	---	---	---	---	---	0.086	---	0.086
Chloroform	---	---	---	---	---	---	0.080	---	0.080
Dichlorobenzene	0.00016	---	---	---	---	---	---	---	0.00016
Ethylene Dibromide	---	---	---	---	---	---	0.12	---	0.12
Methylene Chloride	---	---	---	---	---	---	0.057	---	0.057
Naphthalene	0.000083	---	---	---	---	---	0.21	---	0.21
Phenol	---	---	---	---	---	---	0.067	---	0.067
Styrene	---	---	---	---	---	---	0.066	---	0.066
Tetrachloroethane	---	---	---	---	---	---	0.0070	---	0.0070
Vinyl Chloride	---	---	---	---	---	---	0.042	---	0.042
PAH -POM 1	---	---	---	---	---	---	0.079	---	0.079
POM 2	0.0000080	---	---	---	---	---	0.17	---	0.17
POM 3	0.0000022	---	---	---	---	---	---	---	0.0000022
POM 4	0.00000024	---	---	---	---	---	---	---	0.00000024
POM 5	0.00000032	---	---	---	---	---	---	---	0.00000032
POM 6	0.00000097	---	---	---	---	---	0.00047	---	0.00047
POM 7	0.00000024	---	---	---	---	---	0.0019	---	0.0019
Greenhouse Gases									
CO_2	16,127	105.3	1.61	11.24	36,935	---	660,849	116	714,145
CH_4	0.304	25.0	183.9	53.27	352.0	301.38	12.46	0.00066	928.3
N_2O	0.030	---	---	---	0.062	---	1.25	0.00010	1.3
CO_2e	16,143	630	3,864	1,130	44,345	6,329	661,498	116	734,054

a Assumes maximum development scenario of 2500 gas wells

b Emissions in summary tables may vary slightly due to rounding differences.

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Project: GMBU - Alternative D -Gas Wells

Date: 10/17/2014

Total Project Emissions Summary

Pollutant	Project Emissions (tons/year) [a,b]			Total Emissions (tons/year)
	Development	Production	Infrastructure	
Criteria Pollutants & VOC				
NO_X	647.4	511.1	1,590.2	2,748.7
CO	586.3	523.1	3,226.8	4,336.2
VOC	34.1	3,795.8	1,479.0	5,308.8
SO_2	1.2	2.9	3.4	7.5
PM_{10}	1,117.0	283.0	88.8	1,488.8
$PM_{2.5}$	122.7	61.8	60.9	245.5
Hazardous Air Pollutants				
Benzene	0.52	26.15	13.95	40.62
Toluene	0.19	48.84	10.89	59.92
Ethylbenzene	---	4.99	0.17	5.17
Xylene	0.13	37.30	2.51	39.94
n-Hexane	---	93.56	13.77	107.32
Formaldehyde	0.053	0.36	148.50	148.92
Acetaldehyde	0.017	---	23.50	23.52
Acrolein	0.0053	---	14.47	14.48
Methanol	---	---	7.08	7.08
1,1,2,2-Tetrachloroethane	---	---	0.11	0.11
1,1,2-Trichloroethane	---	---	0.090	0.09
1,3-Dichloropropene	---	---	0.074	0.074
1,3-Butadiene	---	---	0.76	0.76
2,2,4-Trimethylpentane	---	---	0.70	0.70
Biphenyl	---	---	0.59	0.59
Carbon Tetrachloride	---	---	0.10	0.10
Chlorobenzene	---	---	0.086	0.09
Chloroform	---	---	0.080	0.080
Dichlorobenzene	---	0.0058	0.00016	0.0060
Ethylene Dibromide	---	---	0.12	0.12
Methylene Chloride	---	---	0.057	0.057
Naphthalene	0.087	0.0029	0.21	0.30
Phenol	---	---	0.067	0.067
Styrene	---	---	0.066	0.066
Tetrachloroethane	---	---	0.0070	0.0070
Vinyl Chloride	---	---	0.042	0.042
(PAH) POM 1	---	---	0.079	0.079
POM 2	0.051	0.00029	0.17	0.22
POM 3	---	0.000077	0.0000022	0.000079
POM 4	---	0.0000087	0.0000002	0.000009
POM 5	0.00040	0.000012	0.0000003	0.00042
POM 6	0.0016	0.000035	0.00047	0.0021
POM 7	0.0010	0.000009	0.0019	0.0030
Total HAPs	1.05	211.21	238.28	450.54
Greenhouse Gases				
CO_2	116,376	602,127	714,145	1,432,648
CH_4	4.59	7,152	928	8,085
N_2O	0.930	1.13	1.34	3.40
CO_2e	116,760	752,679	734,054	1,603,493

a Emissions for Peak Field Development
b Emissions in summary tables may vary slightly due to rounding differences.

1. Well Pad Construction Emissions (Dozer and Backhoe Fugitive Dust)

Assumptions:

Hours of Construction	0.5	days per well pad
	12	hours per day
	6	hours per well pad
Annual amount of well pads	156	pads/year
Watering Control Efficiency	50	%
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs/hr) = $5.7 * (\text{soil silt content }\%)^{1.2} * (\text{soil moisture content }\%)^{-1.3}$ * Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4}$ * Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0059	0.92	1.97	0.0059	0.92	1.84
PM_{15}	0.50	0.0015	0.23	0.50	0.0015	0.23	0.47
PM_{10}	0.38	0.0011	0.18	0.38	0.0011	0.18	0.35
$PM_{2.5}$	0.21	0.00062	0.10	0.21	0.00062	0.10	0.19

a Assumes one dozer and one backhoe. Backhoe emissions factors are conservatively estimated as equivalent to Dozer emissions.
b Assumes maximum development scenario

2. Well Pad Construction Emissions (Grader Fugitive Dust)

Assumptions:

Hours of Construction	0.5	day grading per well pad
	12	hours/day
	6	hours per well pad
Deep gas well pads	156	well pads/year
Oil well pads	0	well pads/year
Distance graded - Deep gas well	0.23	miles
Distance graded - Oil well	0.00	miles
Watering Control Efficiency	50	%
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency
Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

	Grader Construction Emissions - Deep gas wells			Total Emissions
	lbs/well	lbs/hr/well pad	tons/well pad	tons/year[a]
TSP	0.61	0.10	0.00031	0.048
PM_{15}	0.29	0.049	0.00015	0.023
PM_{10}	0.18	0.029	0.000088	0.014
$PM_{2.5}$	0.019	0.0032	0.0000095	0.0015

a Assumes maximum development scenario

3. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual
$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual
$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily
$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily
$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction Emissions

Hours per day	12	hour/day
Days per pad	0.5	day/well pad
Number of pads per year	156	well pads/year

Vehicle Type[a]	**Weight (lbs)**	**Round Trips per Day per Well**
Haul Trucks	45,000	1
Light Trucks	8,000	2
Mean Vehicle Weight	20,333	---
Total Round Trips	---	3

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	1.20	1.05	5.61	0.015	2.30
$PM_{2.5}$	0.12	0.11	0.56	0.0015	0.23

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-pad**	**ton/year**
PM_{10}	0.015	0.014	0.023	0.000066	0.010
$PM_{2.5}$	0.0036	0.0035	0.0056	0.000016	0.0025

Drilling - Deep Gas Wells

Hours per day	24	hour/day
Days per deep gas well	55	day/well
Number of wells per year	156	wells /year

Vehicle Type[a]	**Weight (lbs)**	**Gas Well Round Trips per Day per Well**
Haul Trucks	45,000	2
Logging/Mud Trucks	40,000	1
Water Trucks	35,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	30,857	---
Total Round Trips	---	7

	Emission Factor		**Unpaved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-well**	**ton/year**
PM_{10}	1.45	1.27	7.90	4.57	712.87
$PM_{2.5}$	0.15	0.13	0.79	0.46	71.29

	Emission Factor		**Paved Road Emisions**		
	Daily	**Annual**			**Total wells**
	lb/VMT	**lb/VMT**	**lb/hr**	**ton/year-well**	**ton/year**
PM_{10}	0.023	0.022	0.041	0.026	4.06
$PM_{2.5}$	0.0055	0.0054	0.010	0.0064	1.00

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3. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$ Annual
$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$ Annual
$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$ Daily
$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$ Daily

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surface Mining Plant Roads
Round Trip Miles	19	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$ Annual
$E(PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$ Daily
$E(PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$ Daily

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	6	
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Interim Reclamation

Hours per day	12	hour/day
Days per pad	1	day/well pad
Number of wells per year	156	wells/year

Vehicle Type[a]	Weight (lbs)	Round Trips per Day per Well
Haul Trucks	45,000	1
Light Trucks	8,000	1
Mean Vehicle Weight	26,500	---
Total Round Trips	---	2

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	1.35	1.19	4.21	0.022	3.46
$PM_{2.5}$	0.14	0.12	0.42	0.0022	0.35

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-pad	ton/year
PM_{10}	0.019	0.019	0.020	0.00012	0.018
$PM_{2.5}$	0.0047	0.0046	0.0049	0.000028	0.0044

Completion - Deep Gas Well

Hours per day	24	hour/day
Days per deep gas well	24	day/well
Number of wells per year	156	wells /year

Vehicle Type[a]	Weight (lbs)	Gas Well Round Trips per Day per Well
Semi/transport/water Trucks	45,000	4
Haul Trucks	45,000	2
Light Trucks	8,000	2
Mean Vehicle Weight	35,750	---
Total Round Trips	---	8

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.55	1.36	9.64	2.43	379.85
$PM_{2.5}$	0.16	0.14	0.96	0.24	37.98

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.026	0.025	0.054	0.015	2.36
$PM_{2.5}$	0.0064	0.0062	0.013	0.0037	0.58

Total Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Total tons/year	Paved Total tons/year	Total tons/year
PM_{10}	1098.48	6.45	1104.92
$PM_{2.5}$	109.85	1.58	111.43

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 60,000 lbs - 80,000 lbs depending on truck type).

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4. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity (U_t)	1.02	m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine)
	1.33	m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	0	acres total disturbance for roads and pipelines per year
	0	square meters total initial disturbance for roads and pipelines
	55	acres total disturbance for well pads per year
	220,958	square meters total initial disturbance for well pads
Exposed Surface Type	Flat	
Meteorological Data	2002 Grand Junction (obtained from NCDC website)	
Fastest Mile Wind Speed (U_{10}^{+})	20.1	meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	4	(Assumption, disturbance at construction and reclamation)

Equations (AP-42 13.2.5.2 Industrial Wind Erosion)

Friction Velocity $U^* = 0.053\, U_{10}^{+}$

Erosion Potential P (g/m^2/period) = $58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, P = 0 for $U^* < U_t^*$

Emissions (tons/year) = Erosion Potential(g/m^2/period)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity[a] m/s	Well Pad Erosion Potential g/m^2-period	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m^2-period
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	1.25	0.00
PM_{10}	0.62	0.00
$PM_{2.5}$	0.093	0.00

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5. Construction Tailpipe Emissions

Assumptions:

Average round trip distance	25	miles
Hours per day for construction	12	hours/day
Days for construction	0.5	days per well pad
Well pads per year	156	well pads/year
Number of heavy diesel truck trips	1	trips/day-well pad
Number of light truck trips	2	trips/day-well pad

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.0005	7.39E-03	0.031	0.00009	0.18	0.086
CO	1.98E-02	0.041	0.00012	7.26E-02	0.30	0.0009	0.34	0.16
VOC	3.16E-03	0.0065	0.00002	3.54E-03	0.015	0.00004	0.021	0.010
SO_2	4.57E-05	0.000095	0.0000003	2.83E-05	0.00012	0.0000004	0.00021	0.00010
PM_{10}	4.22E-03	0.0087	0.00003	1.94E-04	0.00080	0.000002	0.010	0.0045
$PM_{2.5}$	4.09E-03	0.0085	0.00003	1.79E-04	0.00074	0.000002	0.0092	0.0043
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.04	1.61E+00	6.67	0.02	20.61	9.65
CH_4	6.56E-05	0.00014	0.0000004	2.08E-04	0.00086	0.000003	0.0010	0.00047
N_2O	1.20E-05	0.000025	0.00000007	8.05E-05	0.00033	0.0000010	0.00036	0.00017
CO_2e [d]	---	13.95	0.04	---	6.79	0.02	20.75	9.71

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

6. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Development Rate	156	new pads per year
Backhoe Hours	6.0	hours per pad
Backhoe HP	87.17	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Backhoe)
Load Factor	0.21	(Default LF from NONROAD model for Tractors/Loaders/Backhoes)
Dozer Hours	6.0	hours per pad
Dozer HP	136.1	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Dozers)
Load Factor	0.59	(Default LF from NONROAD model for Crawler Tractor/Dozers)
Motor Grader Hours	6.0	hours per pad
Grader HP	231.2	(Average HP based on NONROAD Population file for Utah, assuming highest population count-Graders)
Load Factor	0.59	(Default LF from NONROAD model for Graders)

Equations:

$$\text{Emissions (tons/year/pad)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Horse Power} * \text{Hours} * \text{Load Factor}}{453.6\ \text{(g/lb)} * 2000\ \text{(lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/hp-hr)	Emissions (lb/hr)	Emissions (tons/yr/pad)
Criteria Pollutants & VOC									
NOx	6.9	0.28	0.00084	8.38	1.48	0.0045	8.38	2.52	0.0076
CO	3.49	0.14	0.00042	2.7	0.48	0.0014	2.70	0.81	0.0024
VOC [b]	0.99	0.040	0.00012	0.68	0.12	0.00036	0.68	0.20	0.00061
PM_{10}	0.722	0.029	0.000087	0.402	0.071	0.00021	0.402	0.12	0.00036
$PM_{2.5}$	0.722	0.029	0.000087	0.402	0.071	0.00021	0.402	0.12	0.00036
Greenhouse Gases									
CO_2 [c]	188.2	7.59	0.023	188.2	33.31	0.100	188.2	56.59	0.17
CO_2e [e]	---	7.59	0.023	---	33.31	0.100	---	56.59	0.17

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [d] (tons/yr)
Criteria Pollutants & VOC		
NOx	4.28	2.00
CO	1.43	0.67
VOC	0.36	0.17
PM_{10}	0.22	0.10
$PM_{2.5}$	0.22	0.10
Greenhouse Gases		
CO_2	97.50	45.63
CO_2e [e]	97.50	45.63

a From Table A-4 of Exhaust and Crankcase Emission Factors for NONROAD Engine Modeling - Compression Ignition, EPA-420-R-10-018, July 2010.
b Emission Factor represents total Hydrocarbon Emissions
c Converted from emission factor for Distillate Fuel Oil #2 (diesel) as listed in Table C-1 to Subpart C of Part 98 - Default Emission Factors and High Heat Values for Various Types of Fuel.

Listed Factor: 73.96 kg CO_2/mmBtu
393 hp-hr = mmBtu
188.2 g CO_2/hp-hr

d Assumes maximum development scenario
e Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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7. Drilling Tailpipe Emissions

Assumptions:

Number of deep gas wells drilled	156	wells
Average Round Trip Distance	25	miles
Hours of Operation	1320	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	5	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Trips (trip/day)} * \text{Trip Distance (miles/trip)} * \text{day/well}}{\text{2000 (lb/ton)}}$$

Drilling Vehicles	Heavy Haul Trucks-Deep Gas Wells			Heavy Duty Pickups-Deep Gas Wells			Total-Deep Gas Wells[c]	
	E. Factor[a]	Emissions	Emissions	E. Factor[b]	Emissions	Emissions	Emissions	Emissions
	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/mile)	(lb/hr)	(tons/yr/well)	(lb/hr)	(tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.39	0.25	7.39E-03	0.015	0.0101	0.40	41.25
CO	1.98E-02	0.10	0.068	7.26E-02	0.15	0.0993	0.25	26.04
VOC[c]	3.16E-03	0.016	0.011	3.54E-03	0.0073	0.0048	0.024	2.44
SO_2	4.57E-05	0.00024	0.00016	2.83E-05	0.000059	0.0000	0.00030	0.030
PM_{10}	4.22E-03	0.022	0.014	1.94E-04	0.00040	0.0003	0.022	2.29
$PM_{2.5}$	4.09E-03	0.021	0.014	1.79E-04	0.00037	0.0002	0.022	2.22
Greenhouse Gases								
CO_2	6.73E+00	34.86	23.00	1.61E+00	3.34	2.201	38.19	3932.16
CH_4	6.56E-05	0.00034	0.00022	2.08E-04	0.00043	0.0003	0.00077	0.079
N_2O	1.20E-05	0.000062	0.000041	8.05E-05	0.00017	0.0001	0.00023	0.024
CO_2e[d]	---	34.88	23.02	---	3.40	2.24	38.28	3941.14

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

8. Completion Tailpipe Emissions

Assumptions:

Number of deep gas wells	156	wells
Average Round Trip Distance	24.9	miles
Hours of Operation	576	hours per site (deep gas well)
Number of Heavy Diesel Truck Trips	6	trips/day-well (deep gas well)
Number of Pickup Trips	2	trips/day-well (deep gas well)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/day) * Trip Distance (miles/trip) * day/well}}{\text{2000 (lb/ton)}}$$

Completion Vehicles	**Heavy Haul Trucks-Deep Gas Wells**			**Heavy Duty Pickups-Deep Gas Wells**			**Total-Deep Gas Wells** [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.46	0.13	7.39E-03	0.015	0.004	0.48	21.46
CO	1.98E-02	0.12	0.04	7.26E-02	0.15	0.04	0.27	12.29
VOC [c]	3.16E-03	0.020	0.006	3.54E-03	0.007	0.0021	0.03	1.21
SO_2	4.57E-05	0.0003	0.00008	2.83E-05	0.00006	0.000017	0.0003	0.015
PM_{10}	4.22E-03	0.03	0.008	1.94E-04	0.0004	0.00012	0.03	1.20
$PM_{2.5}$	4.09E-03	0.03	0.007	1.79E-04	0.0004	0.00011	0.03	1.16
Greenhouse Gases								
CO_2	6.73E+00	41.83	12.05	1.61E+00	3.34	0.96	45.16	2029.05
CH_4	6.56E-05	0.0004	0.00012	2.08E-04	0.0004	0.00012	0.0008	0.04
N_2O	1.20E-05	0.00007	0.00002	8.05E-05	0.00017	0.00005	0.00024	0.011
CO_2e [d]	---	41.86	12.06	---	3.40	0.98	45.25	2033

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.
c Assumes maximum development scenario
d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

Project: GMBU - Alternative D -Gas Wells

Date: 10/17/2014

9. Interim Reclamation Tailpipe Emissions

Assumptions:

Number of wells drilled	156	
Average Round Trip Distance	24.9	miles
Hours of Operation	12	hours per site
Number of Heavy Diesel Truck Trips	1	trips/day-well
Number of Pickup Trips	1	trips/day-well

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Trips (trip/well) * Trip Distance (miles/trip)}}{\text{2000 (lb/ton)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [c]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	7.44E-02	0.15	0.00092	7.39E-03	0.015	0.000092	0.169	0.16
CO	1.98E-02	0.041	0.00025	7.26E-02	0.15	0.00090	0.19	0.18
VOC [c]	3.16E-03	0.0065	0.000039	3.54E-03	0.0073	0.000044	0.014	0.013
SO_2	4.57E-05	0.00009	0.00000057	2.83E-05	0.000059	0.00000035	0.00015	0.00014
PM_{10}	4.22E-03	0.0087	0.000052	1.94E-04	0.00040	0.0000024	0.0091	0.0086
$PM_{2.5}$	4.09E-03	0.0085	0.000051	1.79E-04	0.00037	0.0000022	0.0088	0.0083
Greenhouse Gases								
CO_2	6.73E+00	13.94	0.084	1.61E+00	3.34	0.020	17.28	16.17
CH_4	6.56E-05	0.00014	0.00000082	2.08E-04	0.00043	0.0000026	0.00057	0.00053
N_2O	1.20E-05	0.00002	0.00000015	8.05E-05	0.00017	0.0000010	0.00019	0.00018
CO_2e [d]	---	13.95	0.084	---	3.40	0.020	17.35	16.24

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, traveling 15 mph onsite in Uintah County, for calendar year 2012.

c Assumes maximum development scenario

d Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

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Project: GMBU - Alternative D -Gas Wells

Date: 10/17/2014

10. Drill Rig Engine Emissions

Assumptions:

Drilling Hours of Operation	1320	hours/deep gas well
Development Rate	156	deep gas wells/year
Load Factor	0.41	
Drill Rig Engines	2,217	hp
Diesel Fuel Sulfur Content	0.0015	percent (EPA standard value)

Equations:

$$\text{Emissions (ton/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{horsepower (hp)} * \text{Hours (hour/year)} * \text{Load factor}}{\text{2000 lb/ton}}$$

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809 AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 , 10/96

Drill Rig Emissions (Tier 4)

Species	**Drill Rig E. Factor (lb/hp-hr)**	**Drill Rig Emissions (lb/hr)**	**Gas Well Drill Rig Emissions (tons/yr-well)**	**Total Emissions [l] (tons/yr)**
Criteria Pollutants & VOC				
NOx [a]	5.73E-03	5.21	3.44	536.44
CO [a]	5.73E-03	5.21	3.44	536.44
VOC [a]	3.09E-04	0.28	0.19	28.89
PM_{10} [a]	6.61E-05	0.06	0.04	6.19
$PM_{2.5}$ [a]	6.61E-05	0.06	0.04	6.19
SO_2 [b]	1.21E-05	0.011	0.0073	1.14
Hazardous Air Pollutants				
Benzene [c]	5.43E-06	0.0049	0.0033	0.51
Toluene [c]	1.97E-06	0.0018	0.0012	0.18
Xylenes [c]	1.35E-06	0.0012	0.00081	0.13
Formaldehyde [c]	5.52E-07	0.00050	0.00033	0.052
Acetaldehyde [c]	1.76E-07	0.00016	0.00011	0.017
Acrolein [c]	5.52E-08	0.00005	0.000033	0.0052
Naphthalene [d]	9.10E-07	0.00083	0.00055	0.085
POM 2 [d,e,f]	5.39E-07	0.00049	0.00032	0.050
POM 5 [d,e,g]	4.22E-09	0.0000038	0.0000025	0.00040
POM 6 [d,e,h]	1.65E-08	0.000015	0.0000099	0.0015
POM 7 [d,e,i]	1.07E-08	0.000010	0.0000064	0.0010
Greenhouse Gases				
CO_2 [j]	1.14	1037.47	684.73	106,818
CH_4 [j,k]	4.63E-05	0.042	0.028	4.33
N_2O [j,k]	9.26E-06	0.0084	0.0056	0.87
CO_2e [m]	---	1040.96	687.03	107,177

a Emission factors for Tier 4 nonroad diesel engine emission standards from dieselnet.com (NO_X, CO, VOC and PM) Tier IV Emission factors are from the Engines above 560 kW category. Some of the drilling engines are smaller than 560 kW, but these emission factors are more conservative.

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, converted to lb/hp-hr using 7000 Btu/hp-hr

d AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, converted to lb/hp-hr using 7000 Btu/hp-hr

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

g POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

h POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

i POM 7 includes: Chrysene.

j Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

k Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

l Assumes maximum development scenario

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

11. Well Fracturing Engine

Diesel Fuel Sulfur Content	0.0015	percent (typical value)
Typical frac engine horsepower	660	hp (deep gas wells)
Frac engine load factor	0.62	
Hours per frac job	60	hours/well (deep gas wells)
Development Rate - Deep Gas Wells	156	wells/year (deep gas wells)

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7000 Average BTU/hp-hr / 1,000,000

Emissions (tons/year) = Emission Factor (lb/hp-hr) * Horsepower (hp)* Hours (hour/year) * Load Factor / 2000 lb/ton

SO_2 E. Factor (lb/MMBtu) = Fuel sulfur content * 1.01

Species	Frac Engine Emissions E. Factor (lb/MMBtu)	E. Factor (lb/hp-hr)	Gas Well Emissions (lb/hr)	Gas Well Emissions (tons/yr-well)	Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	3.2	0.024	9.82	0.29	45.96
CO [a]	0.85	5.50E-03	2.25	0.07	10.53
VOC [a]	0.09	7.05E-04	0.29	0.009	1.35
PM_{10} [a]	0.10	0.0007	0.29	0.009	1.34
$PM_{2.5}$ [a]	0.10	0.0007	0.29	0.009	1.34
SO_2 [a]	1.52E-03	1.21E-05	0.0050	0.00015	0.023
Hazardous Air Pollutants					
Benzene [b]	7.76E-04	5.43E-06	0.0022	0.000067	0.010
Toluene [b]	2.81E-04	1.97E-06	0.00080	0.000024	0.0038
Xylenes [b]	1.93E-04	1.35E-06	0.00055	0.000017	0.0026
Formaldehyde [b]	7.89E-05	5.52E-07	0.00023	0.0000068	0.0011
Acetaldehyde [b]	2.52E-05	1.76E-07	0.000072	0.0000022	0.00034
Acrolein [b]	7.88E-06	5.52E-08	0.000023	0.00000068	0.00011
Naphthalene [c]	1.30E-04	9.10E-07	0.00037	0.000011	0.0017
POM 2 [c,d,e]	7.70E-05	5.39E-07	0.00022	0.0000066	0.0010
POM 5 [c,d,f]	6.03E-07	4.22E-09	0.0000017	0.000000052	0.000008
POM 6 [c,d,g]	2.36E-06	1.65E-08	0.0000068	0.00000020	0.000032
POM 7 [c,d,h]	1.53E-06	1.07E-08	0.0000044	0.00000013	0.000021
Greenhouse Gases					
CO_2 [i]	163.05	1.14	753.3	22.60	3525.4
CH_4 [j]	6.61E-03	4.63E-05	0.031	0.00092	0.14
N_2O [j]	1.32E-03	9.26E-06	0.0061	0.00018	0.029
CO_2e [l]	---	---	755.8	22.7	3,537.3

a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1

b AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

c AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene

f POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

g POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

h POM 7 includes: Chrysene.

i Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for diesel combustion of 73.96 kg CO_2/MMBtu.

j Table C-2 provides an EF for diesel combustion for CH4 as 3.0E-03 kg/MMBtu and for N2O as 6.0E-04 kg/MMBtu.

k Assumes maximum development scenario

l Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

12. Average Produced Gas Characteristics
Newfield - Average Gas Analysis Composition

Gas Heat Value (wet):	1181.9	Btu/scf
C1-C2 Wt. Fraction:	0.794	
VOC Wt. Fraction:	0.191	
Non-HC Wt. Fraction:	0.015	
Total:	1.000	

Component	Mole Percent	Component Mole Weight (lb/lb-mole)	Net Mole Weight (lb/lb-mole)	Weight Fraction	Gross Heating Value (BTU/scf)	Net Dry Heating Value (BTU/scf)	Lower Heating Value (BTU/scf)	Net Low Heating Value (BTU/scf)
Methane	83.858	16.04	13.453	0.674	1,010	847	910	763
Ethane	7.944	30.07	2.389	0.120	1,770	141	1,618	128.5
Propane	4.313	44.10	1.902	0.095	2,516	108.5	2,316	99.9
i-Butane	0.687	58.12	0.399	0.020	3,252	22.3	3,005	20.6
n-Butane	1.284	58.12	0.746	0.037	3,262	41.9	3,013	38.7
i-Pentane	0.332	72.15	0.240	0.012	4,001	13.29	3,698	12.29
n-Pentane	0.375	72.15	0.270	0.014	4,009	15.02	3,708	13.89
Hexanes+	0.134	86.18	0.116	0.006	4,756	6.39	4,404	5.92
Heptanes	0.055	100.20	0.055	0.003	5,503	3.00	5,100	2.78
Octanes	0.009	114.23	0.010	0.0005	6,249	0.53	----	----
Nonanes	0.0008	128.26	0.0010	0.0001	6,996	0.06	----	----
Decanes	0.0001	142.29	0.0001	0.00001	7,743	0.01	----	----
Benzene	0.0052	78.12	0.0041	0.0002	3,716	0.19	----	----
Toluene	0.0023	92.13	0.0021	0.0001	4,445	0.10	----	----
Ethylbenzene	----	106.16	----	----	5,192	----	----	----
Xylenes	0.0002	106.16	0.0002	0.00001	5,184	0.01	----	----
n-Hexane	0.082	86.18	0.070	0.0035	4,756	3.89	----	----
Helium	----	4.00	----	----	----	----	----	----
Nitrogen	0.647	28.01	0.181	0.0091	----	----	----	----
Carbon Dioxide	0.268	44.01	0.118	0.0059	----	----	----	----
Oxygen	----	32.00	----	----	----	----	----	----
Hydrogen Sulfide	0.005	34.08	0.002	0.0001	637	0.03	588	0.03
Total	**100**	**-**	**20.0**	**1.00**	**-**	**1,203**	**-**	**1,086**

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

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13. Operations Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	261,747	miles/year-all wells
Operation Pickup Truck Mileage:	295,888	miles/year-all wells
Hours of Operation:	10	hours per day
Hours of Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{2000 \text{ (lb/ton)}}$$

Operations Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	3.84	7.01	6.05E-03	0.49	0.90	4.33	7.91
CO	1.02E-02	0.73	1.33	4.48E-02	3.63	6.63	4.36	7.96
VOC [c]	1.55E-03	0.11	0.20	1.61E-03	0.13	0.24	0.24	0.44
SO_2	3.07E-05	0.002	0.004	1.84E-05	0.0015	0.0027	0.0037	0.0067
PM_{10}	2.57E-03	0.18	0.34	1.31E-04	0.011	0.019	0.19	0.36
$PM_{2.5}$	2.50E-03	0.18	0.33	1.21E-04	0.010	0.018	0.19	0.35
Greenhouse Gases								
CO_2	4.520	324.1	591.5	1.050	85.1	155.3	409.3	746.9
CH_4	2.59E-05	0.0019	0.003	9.38E-05	0.008	0.014	0.009	0.017
N_2O	4.01E-06	0.0003	0.0005	2.68E-05	0.0022	0.0040	0.0025	0.004
CO_2e [c]	---	324.3	591.8	---	86.0	156.9	410.2	748.6

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

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Project: GMBU - Alternative D -Gas Wells

Date: 10/17/2014

14. Operations Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$		
Daily	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$		
Annual	$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$		
Annual	$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$		
Silt Content (S)		5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles		19	Mining Plant Roads
Precipitation Days (P)		45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$		
Daily	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$		
Annual	$E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		
Annual	$E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$		
Silt Loading (sL)		0.6	AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of producing wells	2500	wells

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	1.33	1.17	0.061	0.098	244.60
$PM_{2.5}$	0.13	0.12	0.0061	0.0098	24.46

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	29
Light Trucks	8,000	33
Mean Vehicle Weight	25,416	---
Total Round Trips	---	62

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr	ton/year-well	ton/year
PM_{10}	0.018	0.018	0.00028	0.00052	1.29
$PM_{2.5}$	0.0045	0.0045	0.000069	0.000126	0.32

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

15. Gas Well Storage Tanks Working, Breathing, and Flashing Emissions

Assumptions:

Gas well production rate	2.0	barrels/day-well
Total Gas Wells	2500	wells
Tanks at each well pad	1	tanks
Throughput	30,660	gallons per year per tank
Percent of well pads with controls	0	%
Control efficiency of well site tanks	0	%

Calculations:
Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS

Component	Tank Emissions (tons/yr-tank)	Controlled Tank Emissions (tons/yr-tank)	Total Wellsite Emissions [a] (tons/yr)
VOC	0.71	0.00	1773.50
Hazardous Air Pollutants			
Benzene	0.0069	0.00	17.25
Toluene	0.012	0.00	28.75
Ethylbenzene	0.00050	0.00	1.25
Xylenes	0.0041	0.00	10.25
n-Hexane	0.018	0.00	45.50
Greenhouse Gases			
CO_2	0.14	0.00	358.3
CH_4	0.68	0.00	1698.3
CO_2e	14	0.00	36,022

a Total wellsite flashing emissions are based on 2500 uncontrolled tanks and 0 tanks controlled at 0%.

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16. Condensate Truck Loadout

Assumptions:

Deep Gas Well Condensate Production Rate	2.0	bbl/day-well
Number of Deep Gas Wells	2500	wells

AP - 42, Chapter 5.2 $L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)
S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)
P = True Vapor Pressure of the Loaded Liquid (psi)
M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)
T = Temperature of Loaded Liquid (°R)

	S	P	M	T	L_L lb/1000 gal	Production bpd-well	VOC tpy-well	VOC tpy [b]
Condensate Loading [a]	0.6	5.2	66	520	4.94	2.0	0.076	189.22

	Condensate Loading	
	tpy-well [c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.00074	1.84
Toluene	0.0012	3.07
Ethylbenzene	0.000053	0.13
Xylenes	0.00044	1.09
n-Hexane	0.0019	4.85
Greenhouse Gases		
CO_2	0.015	38.22
CH_4	0.072	181.19
CO_2e	1.54	3843.3

Notes:
a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60 °F.
b Assumes maximum development scenario
c Emissions estimated based on ratio of HAP/VOC in tank emissions

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17. Operations Pneumatic Emissions

Pneumatic Device Emissions 1.39 scf/hr

Gas Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Percent	Volume Flow Rate (scf/hr)	Mass Flow Rate (lb/hr)	Mass Flow Rate (tons/yr)
Methane	16.04	83.858	13.453	67.407	1.166	0.049	0.216
Ethane	30.07	7.944	2.389	11.969	0.110	0.0087	0.038
Propane	44.10	4.313	1.902	9.528	0.060	0.0070	0.031
i-Butane	58.12	0.687	0.399	2.000	0.010	0.0015	0.0064
n-Butane	58.12	1.284	0.746	3.740	0.018	0.0027	0.012
i-Pentane	72.15	0.332	0.240	1.201	0.0046	0.00088	0.0038
n-Pentane	72.15	0.375	0.270	1.355	0.0052	0.0010	0.0043
Hexanes	86.18	0.134	0.116	0.580	0.0019	0.00042	0.0019
Heptanes	100.20	0.0546	0.055	0.274	0.00076	0.00020	0.0009
Octanes	114.23	0.0085	0.010	0.049	0.00012	0.000036	0.00016
Nonanes	128.26	0.0008	0.0010	0.0051	0.000011	0.0000038	0.00002
Decanes +	142.29	0.00010	0.0001	0.0007	0.0000014	0.00000052	0.000002
Benzene	78.12	0.00520	0.004	0.020	0.00007	0.000015	0.00007
Toluene	92.13	0.00230	0.002	0.011	0.000032	0.0000078	0.00003
Ethylbenzene	106.16	----	---	---	---	---	---
Xylenes	106.16	0.0002	0.0002	0.0011	0.000003	0.0000008	0.000003
n-Hexane	86.18	0.082	0.070	0.353	0.0011	0.00026	0.001
Nitrogen	28.01	0.647	0.181	0.908	0.0090	0.00066	0.003
Carbon Dioxide	44.01	0.268	0.118	0.591	0.0037	0.00043	0.002
Hydrogen Sulfide	34.08	0.005	0.002	0.009	0.00007	0.00001	0.00003
	VOC Subtotal	7.278	3.816	19.118	0.101	0.014	0.061
	HAP Subtotal	0.090	0.077	0.385	0.001	0.00028	0.0012
	Total	100.000	19.959	100.000	1.390	0.073	0.320

Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
2,500	306.08	1,079.17	9.45	22,672

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers [a]	0.028	0.12
	Totals (per well) =	0.028	0.12

a Emission factor for liquid level controllers is based on Table A-1A of Subpart W - EF for Western U.S. Low Continuous Bleed Pneumatic Device Vents.

18. Production Heater Emissions

Assumptions

Deep Gas Well Dehydrator Heater Size	750	Mbtu/hr
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
Gas wells with dehydrators	2500	wells
Load Factor	0.6	load rate

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Deep Gas Well Dehydrator Heater			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr-well)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	100	0.044	0.19	110.29	483.09
CO [a]	84	0.037	0.16	92.65	405.79
VOC [b]	5.5	0.0024	0.011	6.07	26.57
SO_2 [b]	0.6	0.00026	0.0012	0.66	2.90
PM_{10} [b]	7.6	0.0034	0.015	8.38	36.71
$PM_{2.5}$ [b]	7.6	0.0034	0.015	8.38	36.71
Hazardous Air Pollutants					
Benzene [c]	2.10E-03	9.26E-07	4.06E-06	0.0023	0.010
Toluene [c]	3.40E-03	1.50E-06	6.57E-06	0.0038	0.016
Hexane [c]	1.80E+00	7.94E-04	3.48E-03	1.99	8.70
Formaldehyde [c]	7.50E-02	3.31E-05	1.45E-04	0.083	0.36
Dichlorobenzene [c]	1.20E-03	5.29E-07	2.32E-06	0.0013	0.0058
Naphthalene [c]	6.10E-04	2.69E-07	1.18E-06	0.00067	0.0029
POM 2 [c,d,e]	5.90E-05	2.60E-08	1.14E-07	0.000065	0.00029
POM 3 [c,f]	1.60E-05	7.06E-09	3.09E-08	0.000018	0.00008
POM 4 [c,g]	1.80E-06	7.94E-10	3.48E-09	0.000002	0.00001
POM 5 [c,h]	2.40E-06	1.06E-09	4.64E-09	0.000003	0.00001
POM 6 [c,i]	7.20E-06	3.18E-09	1.39E-08	0.000008	0.00003
POM 7 [c,j]	1.8E-06	7.94E-10	3.48E-09	0.000002	0.00001
Greenhouse Gases					
CO_2 [l]	119,226	52.60	230.39	131,499	575,965
CH_4 [l]	2.25	0.0010	0.0043	2.48	10.86
N_2O [l]	0.22	0.00010	0.00043	0.25	1.09
CO_2e [m]	---	52.65	230.61	131,628	576,530

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98

c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

g POM 4 includes: 3-Methylchloranthrene.

h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

j POM 7 includes: Chrysene.

k Assumes maximum development scenario

l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

19. Deep Gas Well Fugitive Emissions

Number of Producting Wells 2500 wells

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	42	8,760	0.19	4.50E-03	9.95E-03	0.35
Valves - Light Oil	7	8,760	0.50	2.50E-03	5.53E-03	0.08
Valves - Heavy Oil	0	8,760	----	8.40E-06	1.86E-05	----
Valves - Water/Lt. Oil	0	8,760	----	9.80E-05	2.17E-04	----
Connectors - Gas	150	8,760	0.19	2.00E-04	4.42E-04	0.056
Connectors - Light Oil	27	8,760	0.50	2.10E-04	4.64E-04	0.027
Connectors - Heavy Oil	0	8,760	----	7.50E-06	1.66E-05	----
Connectors - Water/ Lt. Oil	0	8,760	----	1.10E-04	2.43E-04	----
Open-Ended Lines - Gas	4	8,760	0.19	2.00E-03	4.42E-03	0.015
Open-Ended Lines - Light Oil	0	8,760	0.50	1.40E-03	3.09E-03	----
Open-Ended Lines - Heavy Oil	0	8,760	----	1.40E-04	3.09E-04	----
Open-Ended Lines - Water/Lt. Oil	0	8,760	----	2.50E-04	5.53E-04	----
Other - Gas	3	8,760	0.19	8.80E-03	1.94E-02	0.049
Other - Light Oil	0	8,760	0.50	7.50E-03	1.66E-02	----
Other - Heavy Oil	0	8,760	----	3.20E-05	7.07E-05	----
Other - Water/Lt. Oil	0	8,760	----	1.40E-02	3.09E-02	----
VOC EMISSIONS (tons/yr-well)						0.58
TOTAL WELLSITE VOC EMISSIONS (tons/yr)[d]						**1452.70**

VOC Emissions (tons/yr) = Emission Factor (lb/hr) * Number of Units * Hours of Operation (hrs/yr) * VOC Wt. Fraction

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B
b Weight fractions from wellsite gas analysis and estimates
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction[b]	Liquid Weight Fraction of VOCs[b]	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	3.97
Toluene Emissions	0.0001	0.0162	5.20
Ethylbenzene Emissions	----	0.0007	0.20
Xylene Emissions	0.00001	0.0058	1.69
n-Hexane Emissions	0.0035	0.0257	28.85

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	49	8,760	0.84	0.0027	0.121	0.92	0.0081	19.36
Connectors - Gas	177	8,760	0.84	0.0027	0.017	0.47	0.0041	9.83
Open-Ended Lines - Gas	4	8,760	0.84	0.0027	0.031	0.019	0.00017	0.40
Other - Light Oil	3	8,760	0.84	0.0027	0.3	0.14	0.0012	2.94
EMISSIONS (tons/yr-well)						1.55	0.0135	32.53
TOTAL WELLSITE GHG EMISSIONS (tons/yr)[d]						**3870.96**	**33.87**	**81324**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B and W-1C
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

20. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate:	0.4	MMscf/day/well
Wells Requiring Dehydrators:	2,500	wells

Gas Composition: 4-36TA-8-17 and 23-2T-9-17 wells

Inlet Gas Conditions: 810 psia, 75 degrees F
Pump: 0.030 acfm gas/gpm glycol
Glycol Circulation Rate: 3 gallons/ lb of water

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95 % Emission Control

Emissions

	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
VOC	0.0043	0.019	47.28
Hazardous Air Pollutants			
Benzene	0.00025	0.0011	2.75
Toluene	0.0011	0.0047	11.64
Ethylbenzene	0.00031	0.0014	3.41
Xylenes	0.0022	0.010	24.25
Greenhouse Gases			
CH_4	0.0068	0.030	73.98
CO_2e	0.14	0.62	1553.48

21. Wellsite Flare Emissions

Assumptions:

Number of gas well dehydrators with controls	2500	well pads
Average Flow to flare	14.2	scf/hr-wellsite
Average Heating Value of Combusted Gas	1900	Btu/scf
Average Heat Rating per Flare	0.03	MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-pad)	Total Emissions (tons/yr-pad)	Total Emissions [c] (lb/hr)	Total Emissions [c] (tons/yr)
Criteria Pollutants					
NOx [a]	0.068	0.002	0.01	4.59	20.09
CO [a]	0.37	0.01	0.04	24.96	109.31
Greenhouse Gases					
CO2 [b]	---	2.28	9.99	5,702	24,975
CH4 [b]	---	0.02	0.10	54.3	238.0
N2O [b]	---	0.00000	0.00002	0.0	0.042
CO2e [b]	---	2.74	11.99	6,846	29,986

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

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Project: GMBU - Alternative D -Gas Wells

Date: 10/17/2014

22. Compressor Station Engines

Assumptions:

Number of new compressor stations	20	facilities
Number of expanded compressor stations	0	facilities
Compressor Engine Capacity	8000	hp

Equations:

Emission factor conversion:

g/hp-hr = AP-42 emission factor (lb/MMbtu) * 8000 Average BTU/hp-hr / 1,000,000 * 453.59 g/lb

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)} * 8760 \text{ (hr/yr)}}{453.6 \text{ g/lb} * 2000 \text{ (lb/ton)}}$$

Pollutant	Emission Factor (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions per Facility (lb/hr-facility)	Emissions per Facility (tons/yr-facility)	Emissions [i] Total (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	17.64	77.25	1544.97
CO [a]	-	2.0	35.27	154.50	3089.95
VOC [a]	-	0.7	12.35	54.07	1081.48
PM_{10} [b,c]	9.95E-03	0.036	0.64	2.79	55.77
$PM_{2.5}$ [b,c]	9.95E-03	0.036	0.64	2.79	55.77
SO_2 [b]	5.88E-04	0.002	0.04	0.16	3.30
Hazardous Air Pollutants [b]					
Benzene	4.40E-04	1.60E-03	0.014	0.062	1.23
Toluene	4.08E-04	1.48E-03	0.013	0.057	1.14
Ethylbenzene	3.97E-05	1.44E-04	0.0013	0.0056	0.11
Xylenes	1.84E-04	6.68E-04	0.0059	0.026	0.52
n-Hexane	1.11E-03	4.03E-03	0.036	0.16	3.11
Formaldehyde	5.28E-02	1.92E-01	1.69	7.40	148.01
Acetaldehyde	8.36E-03	3.03E-02	0.27	1.17	23.43
Acrolein	5.14E-03	1.87E-02	0.16	0.72	14.41
Methanol	2.50E-03	9.07E-03	0.080	0.35	7.01
1,1,2,2-Tetrachloroethane	4.00E-05	1.45E-04	0.0013	0.0056	0.11
1,1,2-Trichloroethane	3.18E-05	1.15E-04	0.0010	0.0045	0.089
1,3-Dichloropropene	2.64E-05	9.58E-05	0.00084	0.0037	0.074
1,3-Butadiene	2.67E-04	9.69E-04	0.0085	0.037	0.75
2,2,4-Trimethylpentane	2.50E-04	9.07E-04	0.0080	0.035	0.70
Biphenyl	2.12E-04	7.69E-04	0.0068	0.030	0.59
Carbon Tetrachloride	3.67E-05	1.33E-04	0.0012	0.0051	0.10
Chlorobenzene	3.04E-05	1.10E-04	0.0010	0.0043	0.085
Chloroform	2.85E-05	1.03E-04	0.00091	0.0040	0.080
Ethylene Dibromide	4.43E-05	1.61E-04	0.0014	0.0062	0.12
Methylene Chloride	2.00E-05	7.26E-05	0.00064	0.0028	0.056
Naphthalene	7.44E-05	2.70E-04	0.0024	0.010	0.21
Phenol	2.40E-05	8.71E-05	0.00077	0.0034	0.067
Styrene	2.36E-05	8.56E-05	0.00076	0.0033	0.066
Tetrachloroethane	2.48E-06	9.00E-06	0.000079	0.00035	0.0070
Vinyl Chloride	1.49E-05	5.41E-05	0.00048	0.0021	0.042
PAH -POM 1 [d,e]	2.69E-05	9.76E-05	0.00086	0.0038	0.075
POM 2 [d,f]	5.93E-05	2.15E-04	0.0019	0.0083	0.17
Benzo(b)fluoranthene/POM6	1.66E-07	6.02E-07	0.000005	0.000023	0.00047
Chrysene/POM7	6.93E-07	2.51E-06	0.000022	0.00010	0.0019
Greenhouse Gases					
CO_2 [g]	117	424	7,481	32,766	655,320
CH_4 [g]	0.002	0.0080	0.14	0.62	12.36
N_2O [g]	0.0002	0.00080	0.014	0.062	1.24
CO_2e [h]	---	---	7,488	32,798	655,963

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00, with 50% control from catalyst for HAPs

c PM = sum of PM filterable and PM condensable

d Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP-42 Table 1.4-3 footnotes.

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html

f POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

g Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

h Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

i Assumes maximum development scenario

23. Compressor Station Condensate Tanks

Assumptions:

Average Condensate Production Rate :

Facility Production Rate	73.5	bbls per day per facility
Tank Control Efficiency	95	%
Total Facilities	20	Compressor Stations
Number of Tanks at Comp Station	4	tanks/facility

Calculations:

Working, Breathing, and Flash Emissions Calculated with E&P Tanks 2.0
Emission factors referenced from Gasco FEIS
Controlled by combustion device with 95% efficiency

Component	**Tank Emissions (tons/yr/Tank)**	**Controlled Tank Emissions (tons/yr/Tank)**	**Total[a] Emissions (tons/yr)**
Total VOC	6.52	0.33	26.07
Hazardous Air Pollutants			
Benzene	0.063	0.0032	0.254
Toluene	0.11	0.0053	0.423
Ethylbenzene	0.0046	0.00023	0.0184
Xylenes	0.038	0.0019	0.151
n-Hexane	0.17	0.0084	0.67
Greenhouse Gases			
CO_2	1.32	1.32	105.33
CH_4	6.24	0.31	24.96
CO_2e	132	7.87	629.6

a Assumes maximum development scenario

24. Compressor Station Dehydrator Emissions

Assumptions

Number of Compressor Stations 20 Stations
Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Dehydrator Emissions (tons/year)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69	233.83
Hazardous Air Pollutants			
Benzene	0.13	0.56	11.20
Toluene	0.090	0.39	7.88
Ethylbenzene	---	---	---
Xylenes	0.016	0.070	1.41
n-Hexane	0.078	0.34	6.79
Greenhouse Gases			
CH_4	3.28	14.35	287.02
CO_2e	68.81	301.38	6027.50

a Assumes maximum development scenario

25. Compressor Station Truck Loadout

Assumptions:

Facility Production Rate	74	bbls per day per facility
Total Facilities	20	

AP - 42, Chapter 5.2

$L_L = 12.46 \times S \times P \times M / T$

L_L = Loading Loss Emission Factor (lbs VOC/1000 gal Loaded)

S = Saturation Factor (0.6 For Submerged Loading - Dedicated Service)

P = True Vapor Pressure of the Loaded Liquid (psi)

M = Vapor Molecular Weight of the Loaded Liquid (lbs/lbmol)

T = Temperature of Loaded Liquid (ºR)

					L_L	Production	VOC	VOC
	S	TVP (psi)[a]	M[a]	T (ºR)	lb/1000 gal	bpd-facility	tpy-facility	tpy[b]
12.46	0.6	5.2	66	520	4.94	74	2.78	55.63

	tpy-facility[c]	tpy[b,c]
Hazardous Air Pollutants		
Benzene	0.027	0.54
Toluene	0.045	0.90
Ethylbenzene	0.0020	0.039
Xylenes	0.016	0.32
n-Hexane	0.071	1.43
Greenhouse Gases		
CO2	0.56	11.24
CH4	2.664	53.27
CO2e	56.50	1129.92

Notes:

a Vapor molecular weight and true vapor pressure from AP-42 Chapter 7, Table 7.1-2, assuming the properties of RVP 10 at 60^{o}F.

b Emission for full buildout

c Emissions estimated based on condensate tank analysis

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26. Compressor Station Truck Tailpipe Emissions

Assumptions:

Total Tanker Truck Mileage:	51,302	miles/year-all wells
Operation Pickup Truck Mileage:	0	miles/year-all wells
Hours of Pumper Operation:	10	hours per day
Hours of Pumper Operation:	3,650	hours per year

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/mile) * Vehicle Miles Traveled (miles/yr)}}{\text{2000 (lb/ton)}}$$

Operations Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [d]	
	E. Factor [a] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	E. Factor [b] (lb/mile)	Emissions (lb/hr)	Emissions[d] (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NOx	5.36E-02	0.75	1.37	6.05E-03	0.00	0.00	0.75	1.37
CO	1.02E-02	0.14	0.26	4.48E-02	0.00	0.00	0.14	0.26
VOC [c]	1.55E-03	0.022	0.040	1.61E-03	0.00	0.00	0.022	0.040
SO_2	3.07E-05	0.0004	0.001	1.84E-05	0.00	0.00	0.0004	0.0008
PM_{10}	2.57E-03	0.036	0.066	1.31E-04	0.00	0.00	0.036	0.066
$PM_{2.5}$	2.50E-03	0.035	0.064	1.21E-04	0.00	0.00	0.035	0.064
Greenhouse Gases								
CO_2	4.520	63.5	115.9	1.050	0.0	0.0	63.5	115.9
CH_4	2.59E-05	0.0004	0.001	9.38E-05	0.00	0.00	0.0004	0.001
N_2O	4.01E-06	0.0001	0.0001	2.68E-05	0.00	0.00	0.0001	0.0001
CO_2e [c]	---	63.6	116.0	---	0.0	0.0	63.6	116.0

a Emission factors developed using EPA MOVES model, assuming Heavy-Heavy Duty Diesel Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

b Emission factors developed using EPA MOVES model, assuming Light Heavy Duty Gasoline Trucks, running exhaust, traveling 45 mph offsite in Uintah County, for calendar year 2012.

c Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

d Assumes maximum development scenario

27. Compressor Station Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

Unpaved Roads

Daily $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45}$

Daily $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$

Annual $E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

Annual $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	5.1	AP 42 13.2.2-1 Mean Silt Content Western Surf.
Round Trip Miles	19	Mining Plant Roads
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

W = average weight in tons of vehicles traveling the road

Paved Calculation AP-42, Chapter 13.2.1
January 2011

Paved Roads

Daily $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02}$

Daily $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02}$

Annual $E (PM_{10}) / VMT = 0.0022 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Annual $E (PM_{2.5}) / VMT = 0.00054 * (sL)^{0.91} * (W)^{1.02} * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-2 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	6.2	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Hours per day	10	hour/day
Number of Compressor Stations	20	facilities

Vehicle Type[a]	Weight (lbs)	Round Trips per Day all Wells
Haul Trucks	45,000	6
Light Trucks	8,000	0
Mean Vehicle Weight	45,000	---
Total Round Trips	---	6

	Emission Factor		Unpaved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	1.72	1.51	0.96	1.54	30.80
$PM_{2.5}$	0.17	0.15	0.096	0.15	3.08

	Emission Factor		Paved Road Emisions		
	Daily	Annual			Total wells
	lb/VMT	lb/VMT	lb/hr-facility	ton/year-facility	ton/year
PM_{10}	0.033	0.033	0.0062	0.0112	0.22
$PM_{2.5}$	0.0081	0.0081	0.0015	0.0028	0.055

Notes:
a Weight of haul trucks, water trucks, and other heavy trucks calculated as average of empty weight (10,000 lbs) and full weight for the round trip (full weight is 80,000 lbs)

28. Compressor Station Fugitive Emissions

Number of Compressor Stations 20 Stations

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	114	8,760	0.19	4.50E-03	9.95E-03	0.95
Valves - Light Oil	28	8,760	0.41	2.50E-03	5.53E-03	0.28
Valves - Heavy Oil	0	8,760	0.41	8.40E-06	1.86E-05	---
Valves - Water/Lt. Oil	28	8,760	0.41	9.80E-05	2.17E-04	0.011
Connectors - Gas	520	8,760	0.19	2.00E-04	4.42E-04	0.19
Connectors - Light Oil	44	8,760	0.41	2.10E-04	4.64E-04	0.04
Connectors - Heavy Oil	0	8,760	0.41	7.50E-06	1.66E-05	---
Connectors - Water/ Lt. Oil	45	8,760	0.41	1.10E-04	2.43E-04	0.020
Open-Ended Lines - Gas	2	8,760	0.19	2.00E-03	4.42E-03	0.0074
Open-Ended Lines - Light Oil	0	8,760	0.41	1.40E-03	3.09E-03	---
Open-Ended Lines - Heavy Oil	0	8,760	0.41	1.40E-04	3.09E-04	---
Open-Ended Lines - Water/Lt. Oil	0	8,760	0.41	2.50E-04	5.53E-04	---
Flanges - Gas	72	8,760	0.19	3.90E-04	8.62E-04	0.052
Flanges - Light Oil	0	8,760	0.41	1.10E-04	2.43E-04	---
Flanges - Heavy Oil	0	8,760	0.41	3.90E-07	8.62E-07	---
Flanges - Water/Lt. Oil	0	8,760	0.41	2.90E-06	6.41E-06	---
Other - Gas	91	8,760	0.19	8.80E-03	1.94E-02	1.48
Other - Light Oil	0	8,760	0.41	7.50E-03	1.66E-02	---
Other - Heavy Oil	0	8,760	0.41	3.20E-05	7.07E-05	---
Other - Water/Lt. Oil	0	8,760	0.41	1.40E-02	3.09E-02	---
Compressor station VOC Emissions (tons/yr)						**3.03**
Total Compressor station VOC Emissions (tons/yr)[d]						**60.55**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components referenced from similar existing facilities
b VOC and HAP weight fractions from wellsite gas analysis and compressor tank emissions
c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017
d Estimated at full project production.

	Gas Weight Fraction	Liquid Weight Fraction of VOCs	Total Emissions[d] (tpy)
Benzene Emissions	0.0002	0.0097	0.124
Toluene Emissions	0.0001	0.016	0.141
Ethylbenzene Emissions	----	0.00070	0.005
Xylene Emissions	0.00001	0.0058	0.043
n-Hexane Emissions	0.0035	0.026	1.17

28. Compressor Station Fugitive Emissions

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	170	8,760	0.84	0.0027	0.121	3.20	0.028	67.17
Connectors - Gas	609	8,760	0.84	0.0027	0.017	1.61	0.014	33.81
Open-Ended Lines - Gas	2	8,760	0.84	0.0027	0.031	0.010	0.000084	0.20
Flanges - Light Oil	72	8,760	0.84	0.0027	0.003	0.034	0.00029	0.71
Other - Light Oil	91	8,760	0.84	0.0027	0.3	4.24	0.037	89.14
Compressor station GHG Emissions (tons/yr)						**9.09**	**0.080**	**191.0**
Total Compressor station GHG Emissions (tons/yr)[d]						**181.85**	**1.591**	**3820.5**

a Number of components referenced from similar existing facilities
b CH_4 and CO_2 mole fractions from wellsite gas analysis
c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A
d Estimated at full project production.

29. Gas Processing Plant Compression

Assumptions:

Number of compressors	4	engines
Compressor horsepower	300	hp/engine

Equations:

$$\text{Emissions (ton/yr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}*8760\text{ (hr/yr)}}{453.6\text{ (g/lb)}*2000\text{ (lb/ton)}}$$

Pollutant	Emission Factor [b] (lb/MMBtu)	Emission Factor [c] (g/hp-hr)	Emissions (lb/hr/engine)	Emissions (ton/yr/engine)	Total Emissions [g] Proposed Action (tons/yr)
Criteria Pollutants & VOC					
NOx [a]	-	1.0	0.66	2.90	11.59
CO [a]	-	2.0	1.32	5.79	23.17
VOC [a]	-	0.7	0.46	2.03	8.11
PM_{10} [b,d]	1.94E-02	7.92E-02	0.052	0.23	0.92
$PM_{2.5}$ [b,d]	1.94E-02	7.92E-02	0.052	0.23	0.92
SO_2 [b]	5.88E-04	2.40E-03	0.0016	0.007	0.028
Hazardous Air Pollutants					
Benzene	1.58E-03	6.45E-03	0.0021	0.0093	0.037
Toluene	5.58E-04	2.28E-03	0.00075	0.0033	0.013
Ethylbenzene	2.48E-05	1.01E-04	0.000033	0.00015	0.00059
Xylenes	1.95E-04	7.96E-04	0.00026	0.0012	0.0046
Formaldehyde	2.05E-02	8.37E-02	0.028	0.12	0.48
Acetaldehyde	2.79E-03	1.14E-02	0.0038	0.016	0.066
Acrolein	2.63E-03	1.07E-02	0.0036	0.016	0.062
Methanol	3.06E-03	1.25E-02	0.0041	0.018	0.072
1,1,2,2-Tetrachloroethane	2.53E-05	1.03E-04	0.000034	0.00015	0.00060
1,1,2-Trichloroethane	1.53E-05	6.25E-05	0.000021	0.000090	0.00036
1,3-Dichloropropene	1.27E-05	5.18E-05	0.000017	0.000075	0.00030
1,3-Butadiene	6.63E-04	2.71E-03	0.00090	0.0039	0.016
Carbon Tetrachloride	1.77E-05	7.23E-05	0.000024	0.00010	0.00042
Chlorobenzene	1.29E-05	5.27E-05	0.000017	0.000076	0.00031
Chloroform	1.37E-05	5.59E-05	0.000018	0.000081	0.00032
Ethylene Dibromide	2.13E-05	8.70E-05	0.000029	0.00013	0.00050
Methylene Chloride	4.12E-05	1.68E-04	0.000056	0.00024	0.0010
Naphthalene	9.71E-05	3.96E-04	0.00013	0.00057	0.0023
Styrene	1.19E-05	4.86E-05	0.000016	0.000070	0.00028
Vinyl Chloride	7.18E-06	2.93E-05	0.000010	0.000042	0.00017
PAH -POM 1	1.41E-04	5.76E-04	0.00019	0.00083	0.0033
Greenhouse Gases					
CO_2 [e]	117	477.2	315.59	1382	5529.1
CH_4 [e]	0.002	9.00E-03	0.0060	0.026	0.10
N_2O [e]	0.0002	9.00E-04	0.00060	0.003	0.010
CO_2e [f]	---	---	315.9	1384	5535

a 40 CFR Part 60 Subpart JJJJ compliant engines

b AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00, with 50% control for HAPs from catalyst

c Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 9000 Btu/hp-hr

d PM = sum of PM filterable and PM condensable

e Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.

f Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

g Estimated at full project production.

30. Gas Processing Plant Dehydrator Emissions

Assumptions

Production Rate: 50 MMscf/day
Gas Composition: Monument Butte Compressor Station Gas Composition

Inlet Gas Conditions: Inlet gas saturated at 800 psig and 125 F
Pump: 0.029acfm gas/gpm glycol

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95 % Control Efficiency

Species	Dehydrator Emissions (lb/hr)	Total Dehydrator Emissions[a] (tons/year)
VOC	2.67	11.69
Hazardous Air Pollutants		
Benzene	0.13	0.56
Toluene	0.090	0.39
Ethylbenzene	---	---
Xylenes	0.016	0.070
n-Hexane	0.078	0.34
Greenhouse Gases		
CH_4	3.28	14.35
CO_2e	68.81	301.38

a Assumes maximum development scenario

31. Gas Processing Plant Fugitives

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	VOC Weight Fraction[b]	Emission Factor[c] (kg/hr-unit)	Emission Factor (lb/hr-unit)	VOC Emissions (tons/yr)
Valves - Gas	72	8,760	0.19	4.50E-03	9.95E-03	0.60
Connectors - Gas	247	8,760	0.19	2.00E-04	4.42E-04	0.091
Open-Ended Lines - Gas	9	8,760	0.19	2.00E-03	4.42E-03	0.033
Other - Gas	5	8,760	0.19	8.80E-03	1.94E-02	0.081
Total Gas Processing Plant VOC Emissions (tons/yr)[d]						**0.81**

$$\text{VOC Emissions (tons/yr)} = \frac{\text{Emission Factor (lb/hr)} * \text{Number of Units} * \text{Hours of Operation (hrs/yr)} * \text{VOC Wt. Fraction}}{\text{2000 (lb/ton)}}$$

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B

b VOC and HAP weight fractions from wellsite gas analysis and tank vent gas analysis

c Emission factors from Table 2.4 - Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017

d Estimated at full project production.

	Gas Weight Fraction	Total Emissions[d] (tpy)
Benzene Emissions	0.00020	0.00086
Toluene Emissions	0.00011	0.00045
Ethylbenzene Emissions	----	----
Xylene Emissions	0.000011	0.000045
n-Hexane Emissions	0.0035	0.015

Equipment Type and Service	No. of Units[a]	Hours of Operation (hrs/yr)	CH_4 Mole Fraction[b]	CO_2 Mole Fraction[b]	Emission Factor[c] (scf/hr/unit)	CH_4 Emissions (tons/yr)	CO_2 Emissions (tons/yr)	CO_2e Emissions (tons/yr)
Valves - Gas	72	8,760	0.84	0.0027	0.121	1.35	0.012	28.45
Connectors - Gas	247	8,760	0.84	0.0027	0.017	0.65	0.0057	13.71
Open-Ended Lines - Gas	9	8,760	0.84	0.0027	0.031	0.043	0.00038	0.91
Other	5	8,760	0.84	0.0027	0.3	0.23	0.0020	4.90
Total Gas Processing Plant GHG Emissions (tons/yr)[d]						**2.05**	**0.018**	**43.07**

a Number of components estimated from 40 CFR Part 98, Subpart W, Tables W-1B

b CH_4 and CO_2 mole fractions from wellsite gas analysis

c Emission factors from 40 CFR Part 98, Subpart W, Table W-1A

d Estimated at full project production.

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Date: 10/17/2014

32. Central Facility Heater Emissions

Assumptions

Gas Processing Dehydrator Reboiler Size	1,500	Mbtu/hr
Compressor Station Dehydrator Reboiler Size	1,500	Mbtu/hr
Operation Hours	8760	hours/year
Fuel Gas Heat Value	1,020	Btu/scf (Standard heating value from AP-42)
	1	Gas Processing Plant
	20	Compressor Station

Equations

$$\text{Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{\text{2,000 (lbs/ton)} * \text{1,020 (Btu/scf - Standard Fuel Heating Value)}}$$

	Compressor Station Reboiler			Gas Processing Plant Reboiler			Total Heater	
	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions [k] (lb/hr)	Total Emissions [k] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.15	0.64	100	0.15	0.64	3.09	13.53
CO [a]	84	0.12	0.54	84	0.12	0.54	2.59	11.36
VOC [b]	5.5	0.008	0.035	5.5	0.008	0.035	0.17	0.74
SO_2 [b]	0.6	0.001	0.0039	0.6	0.001	0.0039	0.019	0.081
PM_{10} [b]	7.6	0.011	0.049	7.6	0.011	0.049	0.23	1.03
$PM_{2.5}$ [b]	7.6	0.011	0.049	7.6	0.011	0.049	0.23	1.03
Hazardous Air Pollutants								
Benzene [c]	2.10E-03	3.09E-06	1.35E-05	2.10E-03	3.09E-06	1.35E-05	0.000065	0.00028
Toluene [c]	3.40E-03	5.00E-06	2.19E-05	3.40E-03	5.00E-06	2.19E-05	0.00011	0.00046
Hexane [c]	1.80E+00	2.65E-03	1.16E-02	1.80E+00	2.65E-03	1.16E-02	0.056	0.24
Formaldehyde [c]	7.50E-02	1.10E-04	4.83E-04	7.50E-02	1.10E-04	4.83E-04	0.0023	0.010
Dichlorobenzene [c]	1.2E-03	1.76E-06	7.73E-06	1.2E-03	1.76E-06	7.73E-06	0.000037	0.00016
Naphthalene [c]	6.1E-04	8.97E-07	3.93E-06	6.1E-04	8.97E-07	3.93E-06	0.000019	0.000083
POM 2 [c,d,e]	5.9E-05	8.68E-08	3.80E-07	5.9E-05	8.68E-08	3.80E-07	0.000002	0.000008
POM 3 [c,f]	1.6E-05	2.35E-08	1.03E-07	1.6E-05	2.35E-08	1.03E-07	0.0000005	0.000002
POM 4 [c,g]	1.8E-06	2.65E-09	1.16E-08	1.8E-06	2.65E-09	1.16E-08	0.0000001	0.0000002
POM 5 [c,h]	2.4E-06	3.53E-09	1.55E-08	2.4E-06	3.53E-09	1.55E-08	0.0000001	0.0000003
POM 6 [c,i]	7.2E-06	1.06E-08	4.64E-08	7.2E-06	1.06E-08	4.64E-08	0.0000002	0.000001
POM 7 [c,j]	1.8E-06	2.65E-09	1.16E-08	1.8E-06	2.65E-09	1.16E-08	0.0000001	0.0000002
Greenhouse Gases								
CO_2 [l]	119,226	175.3	768.0	119,226	175.3	768.0	3,682	16,127
CH_4 [l]	2.25	0.0033	0.014	2.25	0.0033	0.014	0.07	0.30
N_2O [l]	0.22	0.0003	0.001	0.22	0.0003	0.001	0.01	0.03
CO_2e [m]	---	175.5	768.7	---	175.5	768.7	3,686	16,143

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98
b AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are $PM_{1.0}$)
c AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98
d POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata1999/nsata99.html
e POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.
f POM 3 includes: 7,12-Dimethylbenz(a)anthracene.
g POM 4 includes: 3-Methylchloranthrene.
h POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.
i POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.
j POM 7 includes: Chrysene.
k Assumes maximum development scenario
l Subpart W - Part 98.233(z)(1) indicates the use of Table C-1 and Table C-2 for fuel combustion of stationary and portable equipment. Table C-1 provides an EF for natural gas combustion of 53.02 kg CO_2/mmBtu. Table C-2 provides an EF for natural gas combustion for CH_4 as 1.0E-03 kg/MMBtu and for N_2O as 1.0E-04 kg/MMBtu.
m Global warming potential calculated using factors in 40 CFR Part 98, Subpart A, Table A-1.

33. Central Facility Flare Emissions

Assumptions

Number of Compressor Stations 20
Number of Gas Processing Plants 1

*Assume one flare at each facility

Max Heat Rating of Flares 3 MMBtu/hr

	Emission Factor (lb/MMBtu)	Total Emissions (lb/hr-flare)	Total Emissions (tons/yr-flare)	Total Emissions [c] (tons/yr)
Criteria Pollutants				
NOx [a]	0.068	0.20	0.89	18.76
CO [a]	0.37	1.11	4.86	102.10
Greenhouse Gases				
CO2 [b]	---	402	1,759	36,935
CH4 [b]	---	3.83	16.76	352.0
N2O [b]	---	0.0007	0.003	0.062
CO2e [b]	---	482	2,112	44,345

a AP-42 Section 13.5, Industrial Flares, Table 13.5-1, 9/91
b 40 CFR Part 98, Subpart W, Equations W-19, W-20, W-21, and W-40
c Assumes maximum development scenario

50 MMscfd

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: Greater Monument Butte
File Name: W:\Newfield - 387\116133 Greater Monument Butte EIS\2.0 Technical Information\Air Quality\Inventory Calcs\GMB 50 MMscfd Dehy.ddf

DESCRIPTION:

Description: 50 MMscfd/day Dehy
Kimray 21015 glycol pump

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

CONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.0075	0.180	0.0329
Methane	3.2766	78.638	14.3514
Ethane	0.8837	21.210	3.8708
Propane	0.9167	22.001	4.0152
Isobutane	0.2286	5.486	1.0011
n-Butane	0.5091	12.219	2.2299
Isopentane	0.1591	3.819	0.6970
n-Pentane	0.2126	5.102	0.9312
n-Hexane	0.0775	1.861	0.3396
Cyclohexane	0.0524	1.258	0.2296
Other Hexanes	0.0929	2.228	0.4067
Heptanes	0.0809	1.943	0.3545
Methylcyclohexane	0.0362	0.868	0.1584
2,2,4-Trimethylpentane	0.0037	0.088	0.0160
Benzene	0.1279	3.068	0.5600
Toluene	0.0899	2.158	0.3938
Xylenes	0.0161	0.386	0.0704
C8+ Heavies	0.0658	1.580	0.2884
Total Emissions	6.8372	164.093	29.9470
Total Hydrocarbon Emissions	6.8297	163.913	29.9141
Total VOC Emissions	2.6694	64.065	11.6919
Total HAP Emissions	0.3150	7.560	1.3798
Total BTEX Emissions	0.2338	5.612	1.0242

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Hydrogen Sulfide	0.1503	3.608	0.6584
Methane	65.5315	1572.757	287.0281
Ethane	17.6749	424.197	77.4160
Propane	18.3345	440.027	80.3049
Isobutane	4.5713	109.710	20.0221

	50 MMscfd		
n-Butane	10.1822	244.373	44.5981
Isopentane	3.1827	76.386	13.9404
n-Pentane	4.2520	102.047	18.6236
n-Hexane	1.5507	37.216	6.7920
Cyclohexane	1.0484	25.161	4.5918
Other Hexanes	1.8570	44.569	8.1339
Heptanes	1.6189	38.854	7.0909
Methylcyclohexane	0.7234	17.361	3.1685
2,2,4-Trimethylpentane	0.0731	1.753	0.3200
Benzene	2.5570	61.369	11.1999
Toluene	1.7980	43.153	7.8754
Xylenes	0.3215	7.717	1.4083
C8+ Heavies	1.3167	31.602	5.7673
Total Emissions	136.7442	3281.861	598.9396
Total Hydrocarbon Emissions	136.5939	3278.253	598.2812
Total VOC Emissions	53.3875	1281.299	233.8371
Total HAP Emissions	6.3003	151.208	27.5955
Total BTEX Emissions	4.6766	112.239	20.4836

EQUIPMENT REPORTS:

COMBUSTION DEVICE

Ambient Temperature: 0.00 deg. F
Excess Oxygen: 0.00 %
Combustion Efficiency: 95.00 %
Supplemental Fuel Requirement: 7.11e-001 MM BTU/hr

Component	Emitted	Destroyed
Hydrogen Sulfide	5.00%	95.00%
Methane	5.00%	95.00%
Ethane	5.00%	95.00%
Propane	5.00%	95.00%
Isobutane	5.00%	95.00%
n-Butane	5.00%	95.00%
Isopentane	5.00%	95.00%
n-Pentane	5.00%	95.00%
n-Hexane	5.00%	95.00%
Cyclohexane	5.00%	95.00%
Other Hexanes	5.00%	95.00%
Heptanes	5.00%	95.00%
Methylcyclohexane	5.00%	95.00%
2,2,4-Trimethylpentane	5.00%	95.00%
Benzene	5.00%	95.00%
Toluene	5.00%	95.00%
Xylenes	5.00%	95.00%
C8+ Heavies	5.00%	95.00%

ABSORBER

---

50 MMscfd

Calculated Absorber Stages:	2.51
Specified Dry Gas Dew Point:	5.00 lbs. H2O/MMSCF
Temperature:	125.0 deg. F
Pressure:	800.0 psig
Dry Gas Flow Rate:	50.0000 MMSCF/day
Glycol Losses with Dry Gas:	1.8232 lb/hr
Wet Gas Water Content:	Saturated
Calculated Wet Gas Water Content:	137.42 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio:	3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	3.63%	96.37%
Carbon Dioxide	99.73%	0.27%
Hydrogen Sulfide	98.46%	1.54%
Nitrogen	99.97%	0.03%
Methane	99.98%	0.02%
Ethane	99.93%	0.07%
Propane	99.89%	0.11%
Isobutane	99.86%	0.14%
n-Butane	99.82%	0.18%
Isopentane	99.82%	0.18%
n-Pentane	99.78%	0.22%
n-Hexane	99.66%	0.34%
Cyclohexane	98.54%	1.46%
Other Hexanes	99.74%	0.26%
Heptanes	99.43%	0.57%
Methylcyclohexane	98.47%	1.53%
2,2,4-Trimethylpentane	99.74%	0.26%
Benzene	88.60%	11.40%
Toluene	84.62%	15.38%
Xylenes	72.48%	27.52%
C8+ Heavies	97.64%	2.36%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	29.61%	70.39%
Carbon Dioxide	0.00%	100.00%
Hydrogen Sulfide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.37%	99.63%
n-Pentane	0.39%	99.61%
n-Hexane	0.42%	99.58%
Cyclohexane	3.07%	96.93%
Other Hexanes	0.80%	99.20%
Heptanes	0.45%	99.55%
Methylcyclohexane	3.84%	96.16%

50 MMscfd		
2,2,4-Trimethylpentane	1.20%	98.80%
Benzene	4.97%	95.03%
Toluene	7.87%	92.13%
Xylenes	12.92%	87.08%
C8+ Heavies	11.75%	88.25%

STREAM REPORTS:

WET GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.09e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	2.90e-001	2.87e+002
Carbon Dioxide	2.72e-001	6.59e+002
Hydrogen Sulfide	4.99e-003	9.36e+000
Nitrogen	6.45e-001	9.95e+002
Methane	8.36e+001	7.39e+004
Ethane	7.92e+000	1.31e+004
Propane	4.30e+000	1.04e+004
Isobutane	6.85e-001	2.19e+003
n-Butane	1.28e+000	4.10e+003
Isopentane	3.31e-001	1.32e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.16e-002	3.87e+002
Cyclohexane	1.49e-002	6.89e+001
Other Hexanes	1.19e-001	5.66e+002
Heptanes	4.61e-002	2.54e+002
Methylcyclohexane	8.38e-003	4.53e+001
2,2,4-Trimethylpentane	3.59e-003	2.26e+001
Benzene	5.18e-003	2.23e+001
Toluene	2.29e-003	1.16e+001
Xylenes	1.99e-004	1.17e+000
C8+ Heavies	5.78e-003	5.43e+001
Total Components	100.00	1.10e+005

DRY GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia
Flow Rate: 2.08e+006 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	1.05e-002	1.04e+001
Carbon Dioxide	2.72e-001	6.58e+002
Hydrogen Sulfide	4.92e-003	9.21e+000
Nitrogen	6.47e-001	9.95e+002
Methane	8.39e+001	7.39e+004

Ethane	7.94e+000	1.31e+004
Propane	4.31e+000	1.04e+004
Isobutane	6.86e-001	2.19e+003
n-Butane	1.28e+000	4.09e+003
Isopentane	3.32e-001	1.31e+003
n-Pentane	3.74e-001	1.48e+003
n-Hexane	8.15e-002	3.86e+002
Cyclohexane	1.47e-002	6.79e+001
Other Hexanes	1.19e-001	5.64e+002
Heptanes	4.59e-002	2.53e+002
Methylcyclohexane	8.27e-003	4.46e+001
2,2,4-Trimethylpentane	3.59e-003	2.25e+001
Benzene	4.61e-003	1.98e+001
Toluene	1.95e-003	9.85e+000
Xylenes	1.45e-004	8.45e-001
C8+ Heavies	5.66e-003	5.30e+001
Total Components	100.00	1.10e+005

LEAN GLYCOL STREAM

Temperature: 125.00 deg. F
Flow Rate: 1.38e+001 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.85e+001	7.65e+003
Water	1.50e+000	1.17e+002
Carbon Dioxide	2.30e-012	1.79e-010
Hydrogen Sulfide	1.86e-013	1.44e-011
Nitrogen	3.38e-013	2.62e-011
Methane	7.70e-018	5.98e-016
Ethane	5.59e-008	4.34e-006
Propane	6.07e-009	4.71e-007
Isobutane	1.22e-009	9.46e-008
n-Butane	2.41e-009	1.87e-007
Isopentane	1.51e-004	1.17e-002
n-Pentane	2.13e-004	1.65e-002
n-Hexane	8.41e-005	6.53e-003
Cyclohexane	4.27e-004	3.32e-002
Other Hexanes	1.94e-004	1.51e-002
Heptanes	9.41e-005	7.31e-003
Methylcyclohexane	3.72e-004	2.89e-002
2,2,4-Trimethylpentane	1.15e-005	8.90e-004
Benzene	1.72e-003	1.34e-001
Toluene	1.98e-003	1.54e-001
Xylenes	6.14e-004	4.77e-002
C8+ Heavies	2.26e-003	1.75e-001
Total Components	100.00	7.77e+003

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 125.00 deg. F
Pressure: 814.70 psia

50 MMscfd

Flow Rate: 1.46e+001 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.35e+001	7.64e+003
Water	4.81e+000	3.94e+002
Carbon Dioxide	2.71e-002	2.21e+000
Hydrogen Sulfide	1.84e-003	1.50e-001
Nitrogen	1.11e-002	9.05e-001
Methane	8.01e-001	6.55e+001
Ethane	2.16e-001	1.77e+001
Propane	2.24e-001	1.83e+001
Isobutane	5.59e-002	4.57e+000
n-Butane	1.25e-001	1.02e+001
Isopentane	3.91e-002	3.19e+000
n-Pentane	5.22e-002	4.27e+000
n-Hexane	1.90e-002	1.56e+000
Cyclohexane	1.32e-002	1.08e+000
Other Hexanes	2.29e-002	1.87e+000
Heptanes	1.99e-002	1.63e+000
Methylcyclohexane	9.20e-003	7.52e-001
2,2,4-Trimethylpentane	9.04e-004	7.40e-002
Benzene	3.29e-002	2.69e+000
Toluene	2.39e-002	1.95e+000
Xylenes	4.52e-003	3.69e-001
C8+ Heavies	1.82e-002	1.49e+000
Total Components	100.00	8.18e+003

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 7.99e+003 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.31e+001	2.77e+002
Carbon Dioxide	2.39e-001	2.21e+000
Hydrogen Sulfide	2.10e-002	1.50e-001
Nitrogen	1.53e-001	9.05e-001
Methane	1.94e+001	6.55e+001
Ethane	2.79e+000	1.77e+001
Propane	1.97e+000	1.83e+001
Isobutane	3.74e-001	4.57e+000
n-Butane	8.32e-001	1.02e+001
Isopentane	2.10e-001	3.18e+000
n-Pentane	2.80e-001	4.25e+000
n-Hexane	8.55e-002	1.55e+000
Cyclohexane	5.92e-002	1.05e+000
Other Hexanes	1.02e-001	1.86e+000
Heptanes	7.67e-002	1.62e+000
Methylcyclohexane	3.50e-002	7.23e-001
2,2,4-Trimethylpentane	3.04e-003	7.31e-002
Benzene	1.55e-001	2.56e+000
Toluene	9.27e-002	1.80e+000

	50 MMscfd	
Xylenes	1.44e-002	3.22e-001
C8+ Heavies	3.67e-002	1.32e+000
Total Components	100.00	4.17e+002

COMBUSTION DEVICE OFF GAS STREAM

Temperature: 1000.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.06e+002 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Hydrogen Sulfide	7.89e-002	7.52e-003
Methane	7.31e+001	3.28e+000
Ethane	1.05e+001	8.84e-001
Propane	7.44e+000	9.17e-001
Isobutane	1.41e+000	2.29e-001
n-Butane	3.13e+000	5.09e-001
Isopentane	7.89e-001	1.59e-001
n-Pentane	1.05e+000	2.13e-001
n-Hexane	3.22e-001	7.75e-002
Cyclohexane	2.23e-001	5.24e-002
Other Hexanes	3.86e-001	9.29e-002
Heptanes	2.89e-001	8.09e-002
Methylcyclohexane	1.32e-001	3.62e-002
2,2,4-Trimethylpentane	1.14e-002	3.65e-003
Benzene	5.86e-001	1.28e-001
Toluene	3.49e-001	8.99e-002
Xylenes	5.42e-002	1.61e-002
C8+ Heavies	1.38e-001	6.58e-002
Total Components	100.00	6.84e+000

GRI-GLYCalc VERSION 4.0 - AGGREGATE CALCULATIONS REPORT

Case Name: GMB Deep gas well
File Name: C:\Documents and Settings\msteyskal\Desktop\GMB Gas well 2MMscfd.ddf
Date: January 31, 2013

DESCRIPTION:

Description: 0.4 MMscfd throughput
3.0 gal/lb H2O rate
no controls
4-36TA-8-17 and 23-2T-9-17 gas analyses

Annual Hours of Operation: 8760.0 hours/yr

EMISSIONS REPORTS:

UNCONTROLLED REGENERATOR EMISSIONS

Component	lbs/hr	lbs/day	tons/yr
Methane	0.1351	3.243	0.5918
Ethane	0.0032	0.077	0.0140
Propane	0.0003	0.008	0.0014
Isobutane	0.0003	0.006	0.0012
n-Butane	0.0002	0.005	0.0008
Isopentane	0.0001	0.003	0.0006
n-Pentane	0.0001	0.002	0.0004
Other Hexanes	0.0002	0.005	0.0010
Heptanes	0.0008	0.018	0.0033
Benzene	0.0050	0.120	0.0220
Toluene	0.0213	0.510	0.0931
Ethylbenzene	0.0062	0.150	0.0273
Xylenes	0.0443	1.063	0.1940
C8+ Heavies	0.0075	0.181	0.0330
Total Emissions	0.2247	5.392	0.9840
Total Hydrocarbon Emissions	0.2247	5.392	0.9840
Total VOC Emissions	0.0863	2.072	0.3782
Total HAP Emissions	0.0768	1.843	0.3364
Total BTEX Emissions	0.0768	1.843	0.3364

EQUIPMENT REPORTS:

ABSORBER

NOTE: Because the Calculated Absorber Stages was below the minimum allowed, GRI-GLYCalc has set the number of Absorber Stages to 1.25 and has calculated a revised Dry Gas Dew Point.

Calculated Absorber Stages: 1.25
Calculated Dry Gas Dew Point: 2.35 lbs. H2O/MMSCF

Temperature: 75.0 deg. F
Pressure: 810.0 psig

Dry Gas Flow Rate: 0.4000 MMSCF/day
Glycol Losses with Dry Gas: 0.0012 lb/hr
Wet Gas Water Content: Saturated
Calculated Wet Gas Water Content: 31.73 lbs. H2O/MMSCF
Specified Lean Glycol Recirc. Ratio: 3.00 gal/lb H2O

Component	Remaining in Dry Gas	Absorbed in Glycol
Water	7.39%	92.61%
Carbon Dioxide	99.92%	0.08%
Nitrogen	99.99%	0.01%
Methane	100.00%	0.00%
Ethane	99.98%	0.02%
Propane	99.97%	0.03%
Isobutane	99.96%	0.04%
n-Butane	99.94%	0.06%
Isopentane	99.94%	0.06%
n-Pentane	99.92%	0.08%
Other Hexanes	99.89%	0.11%
Heptanes	99.73%	0.27%
Benzene	93.66%	6.34%
Toluene	90.10%	9.90%
Ethylbenzene	86.63%	13.37%
Xylenes	81.02%	18.98%
C8+ Heavies	99.36%	0.64%

REGENERATOR

No Stripping Gas used in regenerator.

Component	Remaining in Glycol	Distilled Overhead
Water	27.72%	72.28%
Carbon Dioxide	0.00%	100.00%
Nitrogen	0.00%	100.00%
Methane	0.00%	100.00%
Ethane	0.00%	100.00%
Propane	0.00%	100.00%
Isobutane	0.00%	100.00%
n-Butane	0.00%	100.00%
Isopentane	0.40%	99.60%
n-Pentane	0.42%	99.58%
Other Hexanes	0.88%	99.12%
Heptanes	0.47%	99.53%
Benzene	4.99%	95.01%
Toluene	7.89%	92.11%
Ethylbenzene	10.40%	89.60%
Xylenes	12.92%	87.08%
C8+ Heavies	11.78%	88.22%

STREAM REPORTS:

WET GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	6.68e-002	5.29e-001
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.72e+001	6.85e+002
Ethane	7.66e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.60e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.51e-002
Other Hexanes	5.00e-003	1.89e-001
Heptanes	6.00e-003	2.64e-001
Benzene	2.30e-003	7.89e-002
Toluene	5.30e-003	2.15e-001
Ethylbenzene	9.99e-004	4.66e-002
Xylenes	5.00e-003	2.33e-001
C8+ Heavies	1.54e-002	1.15e+000
Total Components	100.00	7.35e+002

DRY GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 1.67e+004 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	4.94e-003	3.91e-002
Carbon Dioxide	1.73e+000	3.34e+001
Nitrogen	1.18e-001	1.45e+000
Methane	9.73e+001	6.85e+002
Ethane	7.67e-001	1.01e+001
Propane	3.80e-002	7.36e-001
Isobutane	1.80e-002	4.59e-001
n-Butane	9.99e-003	2.55e-001
Isopentane	6.00e-003	1.90e-001
n-Pentane	3.00e-003	9.50e-002
Other Hexanes	4.99e-003	1.89e-001
Heptanes	5.98e-003	2.63e-001
Benzene	2.15e-003	7.39e-002
Toluene	4.78e-003	1.93e-001
Ethylbenzene	8.66e-004	4.04e-002
Xylenes	4.05e-003	1.89e-001
C8+ Heavies	1.53e-002	1.14e+000
Total Components	100.00	7.34e+002

LEAN GLYCOL STREAM

Temperature: 75.00 deg. F
Flow Rate: 2.23e-002 gpm

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.84e+001	1.23e+001
Water	1.50e+000	1.88e-001
Carbon Dioxide	2.13e-011	2.67e-012
Nitrogen	6.15e-014	7.70e-015
Methane	8.89e-018	1.11e-018
Ethane	6.35e-009	7.95e-010
Propane	7.12e-011	8.92e-012
Isobutane	4.82e-011	6.03e-012
n-Butane	2.98e-011	3.73e-012
Isopentane	4.67e-006	5.84e-007
n-Pentane	3.09e-006	3.87e-007
Other Hexanes	1.62e-005	2.03e-006
Heptanes	2.89e-005	3.62e-006
Benzene	2.10e-003	2.63e-004
Toluene	1.45e-002	1.82e-003
Ethylbenzene	5.79e-003	7.25e-004
Xylenes	5.25e-002	6.57e-003
C8+ Heavies	8.04e-003	1.01e-003
Total Components	100.00	1.25e+001

RICH GLYCOL AND PUMP GAS STREAM

Temperature: 75.00 deg. F
Pressure: 824.70 psia
Flow Rate: 2.38e-002 gpm
NOTE: Stream has more than one phase.

Component	Conc. (wt%)	Loading (lb/hr)
TEG	9.29e+001	1.23e+001
Water	5.11e+000	6.78e-001
Carbon Dioxide	2.39e-001	3.17e-002
Nitrogen	2.21e-003	2.93e-004
Methane	1.02e+000	1.35e-001
Ethane	2.41e-002	3.19e-003
Propane	2.48e-003	3.29e-004
Isobutane	2.03e-003	2.69e-004
n-Butane	1.42e-003	1.88e-004
Isopentane	1.09e-003	1.45e-004
n-Pentane	6.89e-004	9.15e-005
Other Hexanes	1.74e-003	2.31e-004
Heptanes	5.76e-003	7.64e-004
Benzene	3.98e-002	5.28e-003
Toluene	1.74e-001	2.31e-002
Ethylbenzene	5.25e-002	6.97e-003
Xylenes	3.83e-001	5.09e-002
C8+ Heavies	6.44e-002	8.54e-003
Total Components	100.00	1.33e+001

REGENERATOR OVERHEADS STREAM

Temperature: 212.00 deg. F
Pressure: 14.70 psia
Flow Rate: 1.42e+001 scfh

Component	Conc. (vol%)	Loading (lb/hr)
Water	7.29e+001	4.90e-001
Carbon Dioxide	1.93e+000	3.17e-002
Nitrogen	2.80e-002	2.93e-004
Methane	2.26e+001	1.35e-001
Ethane	2.84e-001	3.19e-003
Propane	2.00e-002	3.29e-004
Isobutane	1.24e-002	2.69e-004
n-Butane	8.69e-003	1.88e-004
Isopentane	5.37e-003	1.45e-004
n-Pentane	3.38e-003	9.11e-005
Other Hexanes	7.11e-003	2.29e-004
Heptanes	2.03e-002	7.60e-004
Benzene	1.72e-001	5.01e-003
Toluene	6.18e-001	2.13e-002
Ethylbenzene	1.58e-001	6.24e-003
Xylenes	1.12e+000	4.43e-002
C8+ Heavies	1.19e-001	7.54e-003
Total Components	100.00	7.47e-001

APPENDIX F

ELECTRONIC MODELING FILES

APPENDIX C

Characteristics of Soil Units in the Project Area

SOIL MAP UNIT NAME AND NUMBER	ACREAGE IN PROJECT AREA[1]	SOIL SERIES NAME	SOIL TEXTURE	PARENT MATERIAL	LANDFORM	SLOPE	DEPTH CLASS	DRAINAGE CLASS	RUNOFF	WATER EROSION POTENTIAL (KW)	WIND ERODABILITY INDEX (TONS/AC/YR)	AVAILABLE WATER SUPPLY	ROOTING DEPTH	SAR	RESTORATION POTENTIAL
Badland-Rock outcrop complex, 1 to 100 % slopes (12)	1,177	Badland	---	Soft geologic material	Barren land dissected by intermittent drainage channels	1 to 100 %	Very shallow	---	Very high	0.10	86	0.3	> 200	10	Not rated
		Rock outcrop	---	Bedrock	Cliffs, escarpments, ledges, and erosional remnants	1 to 100 %	---	---	Very high						
Boreham loam, 0 to 2 % slopes (27)	3,583	Boreham	Loam	Loamy alluvium over loamy-skeletal alluvium derived from sedimentary and metamorphic rocks	Fan remnants and strath terraces	0 to 4 %	Very deep	Well drained	Negligible to low	0.37	86	16.33	> 200	6.9	Low
Cadrina extremely stony loam-Rock outcrop complex, 25 to 50 % slopes (36)	23	Cadrina	Extremely stony loam	Slope alluvium and colluvium over residuum derived from shale and sandstone	Hillslopes	2 to 50 %	Very shallow to shallow	Well drained	High	0.05	0	1.9	36	3	Low
		Rock outcrop	---	Bedrock	Cliffs, escarpments, ledges, and erosional remnants	1 to 100 %	---	---	Very high						
Cadrina-Casmos-Rock outcrop complex, 2 to 40 % slopes (38)	8,138	Cadrina	Extremely stony loam	Slope alluvium and colluvium over residuum derived from shale and sandstone	Hillslopes	2 to 50 %	Very shallow to shallow	Well drained	High	0.15	0	1.77	38	3	Low
		Casmos	Channery loam	Slope alluvium and colluvium over residuum from sandstone, siltstone, and shale	Hillslopes, canyons, ridges, and structural benches	2 to 70 %	Very shallow to shallow	Well drained	Low to very high						
		Rock outcrop	---	Bedrock	Cliffs, escarpments, ledges, and erosional remnants	1 to 100 %	---	---	Very high						
Cakehill sandy loam, 2 to 5 % slopes (41)	1,824	Cakehill	Sandy loam	Eolian deposits and slope alluvium over residuum derived from sandstone	Strath terraces	2 to 5 %	Moderately deep	Well drained	Low	0.28	86	9.38	> 200	16.3	Low
Green River loam, 0 to 2 % slopes, occasionally flooded (88)	14	Green River	Loam	Alluvium derived from sedimentary, metamorphic, and igneous rocks	Floodplains, floodplain steps, levees, and terraces	0 to 4 %	Very deep	Somewhat poorly to moderately well drained	Very low to low	0.37	86	7.16	> 200	10.6	Low
Ioka very gravelly sandy loam, 0 to 3 % slopes (113)	263	Ioka	Very gravelly sandy loam	Alluvium and slope alluvium derived from sedimentary and metamorphic rocks	Alluvial flats, alluvial fans, and fan remnants	0 to 25 %	Very deep	Excessively drained	Very low to moderate	0.20	86	4.24	> 200	9	Low
Ioka very gravelly sandy loam, 4 to 25 % slopes (114)	1,928	Ioka	Very gravelly sandy loam	Alluvium and slope alluvium derived from sedimentary and metamorphic rocks	Alluvial flats, alluvial fans, and fan remnants	0 to 25 %	Very deep	Excessively drained	Very low to moderate	0.10	48	4.2	> 200	6.5	Low
Ioka-Cadrina complex, 2 to 25 % slopes (115)	1,441	Ioka	Very gravelly sandy loam	Alluvium and slope alluvium derived from sedimentary and metamorphic rocks	Alluvial flats, alluvial fans, and fan remnants	0 to 25 %	Very deep	Excessively drained	Very low to moderate	0.10	48	3.18	> 200	6.5	Low
		Cadrina	Extremely stony loam	Slope alluvium and colluvium over residuum	Hillslopes	2 to 50 %	Very shallow to shallow	Well drained	High						

SOIL MAP UNIT NAME AND NUMBER	ACREAGE IN PROJECT AREA[1]	SOIL SERIES NAME	SOIL TEXTURE	PARENT MATERIAL	LANDFORM	SLOPE	DEPTH CLASS	DRAINAGE CLASS	RUNOFF	WATER EROSION POTENTIAL (KW)	WIND ERODABILITY INDEX (TONS/AC/YR)	AVAILABLE WATER SUPPLY	ROOTING DEPTH	SAR	RESTORATION POTENTIAL
				derived from shale and sandstone											
Jenrid sandy loam, 0 to 2 % slopes (120)	2,355	Jenrid	Sandy loam	Alluvium derived from sedimentary rocks	Alluvial flats	0 to 2%	Very deep	Well drained	Low	0.28	86	7.25	> 200	8	Low
Jenrid-Green River Complex, 0 to 2 % slopes (122)	554	Jenrid	Sandy loam	Alluvium derived from sedimentary rocks	Alluvial flats	0 to 2%	Very deep	Well drained	Low	0.28	86	7.09	> 200	8	Low
		Green River	Loam	Alluvium derived from sedimentary, metamorphic, and igneous rocks	Floodplains, floodplain steps, levees, and terraces	0 to 4 %	Very deep	Somewhat poorly to moderately well drained	Very low to low						
Kilroy loam, 1 to 4 % slopes (123)	8,381	Kilroy	Loam	Alluvium derived from sandstone and quartzite	Fan remnants and strath terraces	1 to 4 %	Very deep	Well drained	Low	0.37	86	14.16	> 200	4.5	Low
Leebench sandy loam, 0 to 2 % slopes (128)	2,572	Leebench	Gravelly clay loam	Alluvium derived from sedimentary and metamorphic rocks	Alluvial fans, fan remnants, strath terraces, stream terraces, alluvial flats, and fan terraces	0 to 10 %	Very deep	Well drained	Moderate	0.28	86	10.91	> 200	21.6	Low
Leeko loam, 0 to 4 % slopes (129)	1,417	Leeko	Loam	Alluvium derived from sedimentary and metamorphic rocks	Strath terraces	0 to 4 %	Very deep	Well drained	Low to moderate	0.37	86	15.26	> 200	24.6	Low
Mikim silt loam, 2 to 4 % slopes (138)	24	Mikim	Loam	Alluvium derived from sandstone and shale	Alluvial fans, drainageways, and valleys	0 to 15 %	Very deep	Well drained	Negligible to moderate	0.55	86	16.6	> 200	4.7	Low
Smithpond-Montwel-Badland association, 3 to 25% slopes (142)	2,574	Smithpond	Gravelly fine sandy loam	Alluvium and eolian deposits derived from interbedded calcareous sedimentary rocks	Fan remnants, alluvial fans, structural benches, and mesas	1 to 8 %	Very deep	Well drained	Very low to low	0.24	86	---	> 200	2.5	Moderate
		Montwel	Loam	Slope alluvium and colluvium over residuum from variegated shale, siltstone, and sandstone	Hillslopes	2 to 90 %	Moderately deep	Well drained	Low to high						
		Badland	---	Soft geologic material	Barren land dissected by intermittent drainage channels	1 to 100 %	Very shallow	---	Very high						
Motto-Muff-Rock Outcrop complex, 2 to 25 % slopes (153)	1,988	Motto	Extremely channery sandy loam	Slope alluvium over residuum derived from shale and sandstone	Hills and structural benches	2 to 25 %	Shallow	Well drained	Moderate to very high	0.15	48	8.8	43	35.4	Low
		Muff	Fine sandy loam	Residuum and slope alluvium weathered from sandstone or shale	Hillslopes, strath terraces, and summits	0 to 30 %	Moderately deep	Well drained	Low to high						
		Rock outcrop	---	Bedrock	Cliffs, escarpments, ledges, and erosional remnants	1 to 100 %	---	---	Very high						
Motto-Rock outcrop complex, 2 to 25 % slopes (154)	17,175	Motto	Extremely channery sandy loam	Slope alluvium over residuum derived from shale and sandstone	Hills and structural benches	2 to 25 %	Shallow	Well drained	Moderate to very high	0.15	48	6.71	43	35.4	Low
		Rock outcrop	---	Bedrock	Cliffs, escarpments, ledges, and erosional remnants	1 to 100 %	---	---	Very high						

SOIL MAP UNIT NAME AND NUMBER	ACREAGE IN PROJECT AREA[1]	SOIL SERIES NAME	SOIL TEXTURE	PARENT MATERIAL	LANDFORM	SLOPE	DEPTH CLASS	DRAINAGE CLASS	RUNOFF	WATER EROSION POTENTIA L (KW)	WIND ERODABILITY INDEX (TONS/AC/YR)	AVAILABL E WATER SUPPLY	ROOTIN G DEPTH	SA R	RESTORATION POTENTIAL
Motto-Uffens complex, 2 to 25 % slopes (155)	997	Motto	Extremely channery sandy loam	Slope alluvium over residuum derived from shale and sandstone	Hills and structural benches	2 to 25 %	Shallow	Well drained	Moderate to very high	0.15	48	9.47	43	35.4	Low
		Uffens	Silt loam	Deltaic and alluvial sediments derived from mixed parent material	Terraces and fans	0 to 12 %	Very deep	Well drained	Very low to low						
Muff gravelly sandy loam, 2 to 8 % slopes (158)	4,201	Muff	Fine sandy loam	Residuum and slope alluvium weathered from sandstone or shale	Hillslopes, strath terraces, and summits	0 to 30 %	Moderately deep	Well drained	Low to high	0.15	56	11.37	> 200	23.1	Low
Nakoy loamy fine sand, 1 to 5 % slopes (160)	1,485	Nakoy	Loamy fine sand	Eolian material over alluvium derived from sedimentary and metamorphic rocks	Fan remnants	0 to 5 %	Very deep	Well drained	Negligible to very low	0.28	134	11.28	> 200	7.7	Low
Pariette gravelly sandy loam, 2 to 8 % slopes (173)	4,262	Pariette	Loam	Slope alluvium over residuum derived from shale interbedded with sandstone and siltstone	Fan remnants and strath terraces	2 to 8 %	Moderately deep	Well drained	Low to moderate	0.15	56	5.97	> 200	8.5	Low
Pherson-Hickerson complex, 1 to 8 % slopes (179)	302	Pherson	Gravelly loam	Alluvium derived from sandstone and shale	Alluvial fans, drainageways, and floodplain steps	2 to 15 %	Very deep	Well drained	Very low to low	0.15	48	12.38	> 200	7.9	Low
		Hickerson	Loam	Alluvium derived from sandstone, shale, limestone, and quartzite rocks	Floodplains and alluvial flats	1 to 4 %	Very deep	Moderately well drained	Low						
Rock outcrop (193)	67	Rock outcrop	---	Bedrock	Cliffs, escarpments, ledges, and erosional remnants	1 to 100 %	---	---	Very high	Not rated	0	Not rated	0	0	Not rated
Shotnick sandy loam, 2 to 4 % slopes (206)	320	Shotnick	Sandy loam	Alluvium or eolian deposits over alluvium derived from sedimentary rocks	Alluvial flats, terraces, and hill toeslopes	0 to 25 %	Very deep	Well drained	Negligible to moderate	0.32	86	12.8	> 200	3	Low
Uffens loam, 3 to 8 % slopes (249)	7,395	Uffens	Silt loam	Deltaic and alluvial sediments derived from mixed parent material	Terraces and fans	0 to 12 %	Very deep	Well drained	Very low to low	0.42	86	13.6	> 200	18.9	Low
Uffens sandy loam, 0 to 2 % slopes (250)	1,857	Uffens	Silt loam	Deltaic and alluvial sediments derived from mixed parent material	Terraces and fans	0 to 12 %	Very deep	Well drained	Very low to low	0.32	86	9.54	> 200	21	Low
Umbo silty clay loam, 0 to 2 % slopes (252)	1,288	Umbo	Clay loam	Alluvium derived from quartzite, sandstone, shale, and limestone rocks	Alluvial flats	0 to 4 %	Very deep	Somewhat poorly to moderately well drained	Negligible to low	0.28	86	13.51	> 200	8	Low
Walknolls extremely channery sandy loam, 4 to 25 % slopes (256)	3,749	Walknolls	Channery sandy loam	Slope alluvium, colluvium, and residuum from sandstone	Hills, ridges, mesas, escarpments on cuestas, and side slopes	2 to 90 %	Very shallow to shallow	Well drained	Very low to very high	0.05	0	1.44	36	7.3	Low
Walknolls-Rock Outcrop complex, 2 to 50 % slopes (264)	3,271	Walknolls	Channery sandy loam	Slope alluvium, colluvium, and residuum from sandstone	Hills, ridges, mesas, escarpments on cuestas, and side slopes	2 to 90 %	Very shallow to shallow	Well drained	Very low to very high	0.10	48	1.88	43	7.1	Low
		Rock outcrop	---	Bedrock	Cliffs, escarpments, ledges, and erosional remnants	1 to 100 %	---	---	Very high						

SOIL MAP UNIT NAME AND NUMBER	ACREAGE IN PROJECT AREA[1]	SOIL SERIES NAME	SOIL TEXTURE	PARENT MATERIAL	LANDFORM	SLOPE	DEPTH CLASS	DRAINAGE CLASS	RUNOFF	WATER EROSION POTENTIAL (KW)	WIND ERODABILITY INDEX (TONS/AC/YR)	AVAILABLE WATER SUPPLY	ROOTING DEPTH	SAR	RESTORATION POTENTIAL
Walknolls-Uendal association, 2 to 25 % slopes (266)	17,550	Walknolls	Channery sandy loam	Slope alluvium, colluvium, and residuum from sandstone	Hills, ridges, mesas, escarpments on cuestas, and side slopes	2 to 90 %	Very shallow to shallow	Well drained	Very low to very high	0.10	48	3.51	43	7.1	Low
		Uendal	Gravelly sandy loam	Slope alluvium derived from sandstone	Hillslopes	4 to 8 %	Moderately deep	Well drained	Low						
Uffens-Rock outcrop complex, 15 to 25 % slopes (CZE2)	1,665	Uffens	Silt loam	Deltaic and alluvial sediments derived from mixed parent material	Terraces and fans	0 to 12 %	Very deep	Well drained	Very low to low	Not rated	0	---	0	0	Not rated
		Rock outcrop	---	Bedrock	Cliffs, escarpments, ledges, and erosional remnants	1 to 100 %	---	---	Very high						
Braf-Rock outcrop-Uffens complex, 5 to 50 % slopes (EZF2)	11,174	Braf	Sandy loam	Eolian deposits and slope alluvium and residuum derived from sandstone	Mesas and structural benches	2 to 15 %	Shallow to very shallow	Somewhat excessively to excessively drained	Low to high	Not rated	0	---	0	0	Not Rated
		Rock outcrop	---	Bedrock	Cliffs, escarpments, ledges, and erosional remnants	1 to 100 %	---	---	Very high						
		Uffens	Silt loam	Deltaic and alluvial sediments derived from mixed parent material	Terraces and fans	0 to 12 %	Very deep	Well drained	Very low to low						
Mikim loam, 2 to 5 % slopes (MaB)	980	Mikim	Loam	Alluvium derived from sandstone and shale	Alluvial fans, drainageways, and valleys	0 to 15 %	Very deep	Well drained	Negligible to moderate	0.31	48	---	> 200	0	Moderate
Cheeta-Rock outcrop complex, 30 to 80% slopes (RAL)	871	Cheeta	Extremely channery fine sandy loam	Slope alluvium and colluvium over residuum derived from limestone and sandstone	Canyons, cuestas, mesas, and mountain slopes	30 to 80 %	Very shallow to shallow	Well drained	---	0.07	48	---	5	2	Low
		Rock outcrop	---	Bedrock	Cliffs, escarpments, ledges, and erosional remnants	1 to 100 %	---	---	Very high						
Undocumented	2,703	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Water (258)	177	---	---	---	---	---	---	---	---	---	---	---	---	---	---

[1] Total acreage estimates for the Project Area are based on GIS-software calculations and may not equal total acreage by soil map unit due to rounding, removal of overlapping development, and minute boundary discrepancies. GIS-based calculations are considered more accurate than estimates calculated using simple addition.

Sources: USDA 2003; http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx; draft soil mapping from Price Utah NRCS.

APPENDIX D

Summary of Potential Occurrence of Special Status Plant Species for Monument Butte Project Area

SPECIES	STATUS[1]	HABITAT ASSOCIATION	POTENTIAL FOR OCCURRENCE WITHIN THE PROPOSED MONUMENT BUTTE PROJECT AREA AND CUMULATIVE EFFECTS AREA	ELIMINATED FROM DETAILED ANALYSIS? (YES/NO)
Plants				
Ackerman's frasera *Frasera ackermaniae*	S	Clay semi-barrens on the Chinle Formation with scattered *Juniperus osteosperma*; 5,830 to 6,000 feet; flowers June.	None. Species is endemic to a 40 acre area in northern Uintah County	Yes. Species range is outside of Project Area.
Barneby's catseye *Cryptantha barnebyi*	S	White, semi-barren shale knolls of the Green River Formation; oil shale; gently sloping white shale barrens; shadscale-saltbush or pinyon-juniper communities; 6,000-7,900 feet.	Moderate. Formation and associated soils occur in the Project Area. However, little is known about the species' exact habitat requirements	No. Potential habitat occurs in the Project Area.
Barnaby's ridgecress *Lepidium barnebyanum*	E	Tribal lands in Duchesne County. Tavaputs Plateau; Uinta Formation; white shale ridgecrests; pinyon-juniper community; 6,200-6,500 feet; flowers May - June.	None. No potential habitat. Known populations occur outside of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Clay reed-mustard *Schoenocrambe argillacea*	T	Grows in steep, nearly inaccessible sites such as are unlikely to have been altered much by recent human activity, sc.: narrow ledges and overhangs of steep, north-facing slopes, often in somewhat protected nooks, crevices and cavities. Preferred soils are usually clayey sand derived from shales and sandstones in the contact zone of the Uinta and Green River Formations. It has also been reported growing on soils rich in gypsum, and on the Evacuation Creek Member of the Green River Formation.	None. No potential habitat. Known populations occur south and outside of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Gibben's penstemon *Penstemon gibbensii*	S	Shaly slopes and bluffs along the Green River, with mixed desert shrubs and scattered juniper; 5,500 to 7,700 feet; flowers June.	None. Species is endemic to Daggett County and does not occur near Project Area.	Yes. Project Area does not occur in species range.
Goodrich's blazingstar *Mentzelia goodrichii*	S	Steep, white, calciferous shale cliffs of the Green River Formation; escarpments of Willow & Argyle Canyons; open mountain brush communities; 8,100-8,800 feet.; flowers July - August.	Moderate. Formation and associated soils occur in the Project Area. However, little is known about the species' exact habitat requirements	Yes. Project Area does not occur in elevation range.
Goodrich's columbine *Aquilegia scopulorum var. goodrichii*	S	Green River shale ridges; bristlecone pine, limber pine, Salina wildrye, mountain mahogany, pinyon, and Douglas-fir communities; 7,400 to 9,400 feet	Moderate. Formation and associated soils occur in the Project Area. However, little is known about the species' exact habitat requirements	Yes. Project Area does not occur in elevation range.

SPECIES	STATUS[1]	HABITAT ASSOCIATION	POTENTIAL FOR OCCURRENCE WITHIN THE PROPOSED MONUMENT BUTTE PROJECT AREA AND CUMULATIVE EFFECTS AREA	ELIMINATED FROM DETAILED ANALYSIS? (YES/NO)
Goodrich's penstemon *Penstemon goodrichii*	S	Duchesne and Uintah County, near Lapoint, Tridell, Whiterocks; Duchesne River Formation; clay badlands; desert shrub, shadscale, pinyon-juniper or mountain brush communities; 5,590-6,215 feet.; flowers late May - June.	None. No potential habitat. Known populations occur in northern Uintah County; outside of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Goodrich cleomella *Cleomella palmeriana* var. *goodrichii*	S	Morrison Formation, heavy clay; mat-salt-bush, Cicsco woody aster, salt desert shrub community; 4,000-6,000 feet; flowers May.	None. No potential habitat. The geological formation and soils associated with this species do not occur in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Graham's catseye *Cryptantha grahamii*	S	Green River Formation shale in mixed desert shrub, sagebrush, pinyon-juniper, and mountain brush communities; 5,000-7,400 feet.	Moderate. Formation and associated soils occur in the Project Area. However, little is known about the species' exact habitat requirements	No. Potential habitat occurs in the Project Area.
Graham's beardtongue (Graham's penstemon) *Penstemon grahamii*	P	Grows directly on the weathered exposures of oil-shale strata associated with the Parachute Creek Member and Evacuation Creek Member of the Green River Formation. Oil shale or white shale knolls & talus; semi-barren mixed desert shrub or pinyon-juniper communities; 4,600-6,700 feet; flowers from late May - mid-June.	Low. The geological formation and soils associated with this species does not occur. Known populations are located south and east of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Green River greenthread *Thelesperma caespitosum*	S	White shale benches and windswept slopes of the Green River and Uinta Formation with pinyon-juniper and mountain mahogany communities;. 5,900–8,400 feet.	Moderate. Formation and associated soils occur in the Project Area. However, little is known about the species' exact habitat requirements.	No. Potential habitat occurs in the Project Area.
Hamilton milkvetch *Astragalus hamiltonii*	S	Duchesne River, Mowry, Dakota & Wasatch Formations; mixed desert shrub or pinyon-juniper communities; 5,240-5,800 feet; flowers May-June.	None. No populations, potential or suitable habitat occurs for this species in this area. Known populations occur near Vernal; outside of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Horseshoe milkvetch *Astragalus equisolensis*	S	East of Green River, Horseshoe Bend; Duchesne River Formation soils; mixed desert shrub communities; 4,790-5,185 feet.; flowers May-early June.	None. No populations, potential or suitable habitat occurs for this species in this area. Known populations occur along the upper Green River; outside of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Huber's pepperplant *Lepidium huberi*	S	Uinta Mountain foothills, Book Cliffs; Chinle, Park City, Weber Formation; eroding cliffs, alluvium; black	None. No potential habitat. The geological formation and soils associated with this species do not occur in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.

SPECIES	STATUS[1]	HABITAT ASSOCIATION	POTENTIAL FOR OCCURRENCE WITHIN THE PROPOSED MONUMENT BUTTE PROJECT AREA AND CUMULATIVE EFFECTS AREA	ELIMINATED FROM DETAILED ANALYSIS? (YES/NO)
		sage or mountain brush communities; 5,000-9,700 feet.; flowers June-August.		
Park rock cress *Arabis vivariensis*	S	Weber Formation sandstone & limestone outcrops; mixed desert shrub or pinyon-juniper communities; 5,000-6,000 feet; flowers May.	None. The geological formation and soils associated with this species do not occur in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Pariette cactus *Sclerocactus brevispinus*	T	Pariette Bench south of Myton, grows in flat soil surfaces to slightly rolling hills. Preferred soils are the fine alkaline clays overlain by a pavement of hard, flat, angular, desert-varnished sandstone fragments derived from the Wagonhound Member of the Uinta Formation; shadscale, mat-saltbush community; 4,700-5,400 feet.	High. The Project Area is located within the USFWS *Sclerocactus* polygon.	No. Suitable habitat is present in the Project Area.
Rock bitterweed *Hymenoxys lapidicola*	S	Blue Mountain; Weber Formation, sandy ledges & crevices; pinyon-juniper or ponderosa-manzanita communities; 5,700-8,100 feet; flowers June.	None. The geological formation and soils associated with this species do not occur in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Shrubby reed-mustard *Schoencrambe suffrutescens*	E	Duchesne, Uintah: Green River Formation; Badlands Cliffs, Gray Knolls, Big Pack Mountain; calcareous shale; mixed desert shrub, pinyon-juniper or mountain brush communities; 5,400-6,000 feet.; flowers late May - mid-August.	None. The geological formation and soils associated with this species do not occur. Known populations occur south and southeast of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Sterile Yucca *Yucca sterilis*	S	Salt and mixed desert shrub communities growing in sandy soils, 4,800-5,800 feet.	Moderate. Formation and associated soils occur in the Project Area.	No. Potential habitat occurs in the Project Area.
Stemless penstemon *Penstemon acaulis var. acaulis*	S	Pinyon-juniper and sagebrush-grass communities on semi-barren substrates; 5,900-8,200 feet; flowers June-July.	None. Species is endemic to Daggett County and does not occur near Project Area.	Yes. Project Area does not occur in species range.
Uinta Basin hookless cactus *Sclerocactus wetlandicus*	T	Found within clay bad-lands all the way up into pinyon-juniper habitats. At the species core its preferred habitat seems to be Pleistocene outwash terraces with xeric, coarse-textured, alkaline soils overlain by a surficial pavement of large, smooth, rounded cobble. It occurs most commonly on south-	High. The Project Area is located within the USFWS *Sclerocactus* polygon.	No. Suitable habitat is present in the Project Area.

SPECIES	STATUS[1]	HABITAT ASSOCIATION	POTENTIAL FOR OCCURRENCE WITHIN THE PROPOSED MONUMENT BUTTE PROJECT AREA AND CUMULATIVE EFFECTS AREA	ELIMINATED FROM DETAILED ANALYSIS? (YES/NO)
		facing exposures, where terrace deposits break from level slopes to steeper side slopes at approximately 30% grade, between 4,500-5,900 feet.		
Untermann daisy *Erigeron untermannii*	S	West Tavaputs Plateau; Green River, Uinta Formation; ridges; dry calcereaous shales and sandstones; pinyon-juniper or mountain brush communities; 7,000-9,400 feet. Flowers May–June.	Moderate. There are known populations in the vicinity of the Project Area within the Indian Canyon.	Yes. Project Area does not occur in elevation range.
Ute ladies'-tresses *Spiranthes diluvialis*	T	Green River tributaries, Uinta Mountains, Browns Park, Book Cliffs; unconsolidated alluvium; wetland meadow communities; 4,400-6,810 feet.; flowers late July - September	Low. No known populations exist in the Project Area, but potential habitat may occur in association with riparian areas.	No. Potential habitat may be present along riparian areas.
White River beardtongue *Penstemon scariosus* var. *albifluvis*	P	Grows on raw shale barrens and oil shale barrens of the Evacuation Creek and Para-chute Creek Member of the Green River Formation. Soils are xeric, calcareous, fine-textured, whitish or reddish clays overlain by a white shale chips; 5,000-6,800.	None. Known populations occur in the upper White River; east of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.

[1] Status: E = federally listed as endangered; T = federally listed as threatened; P = federal proposed species; S = BLM sensitive species, Vernal Field Office

Source: Adapted from BLM Vernal Field Office, Special Status Plant Species List (UDWR 2011b).
Source for location information: USFWS 2012, UNPS 2007, and Goodrich and Neese 1986.

APPENDIX E

Summary of Potential Occurrence of Special Status Fish and Wildlife Species for Monument Butte Project Area

SPECIES	STATUS[1]	HABITAT ASSOCIATION	POTENTIAL FOR OCCURRENCE WITHIN THE PROPOSED MONUMENT BUTTE PROJECT AREA AND CUMULATIVE EFFECTS AREA	ELIMINATED FROM DETAILED ANALYSIS? (YES/NO)
Birds				
American white pelican *Pelecanus erythrorhynchos*	S SPC	Inhabits areas of open water including large rivers, lakes, ponds, and reservoirs with surrounding habitats ranging from barren to heavily vegetated sites. Typically nests on isolated islands in lakes or reservoirs.	Low. In Utah, the species is known to nest on islands associated with Great Salt and Utah lakes.	**No. Potential habitat for this species occurs along the eastern edge of the Project Area.**
Bald eagle *Haliaeetus leucocephalus*	BGEPA SPC	In Utah, breeding occurrences are limited to eight locations within four counties (Daggett, Davis, Grand, Duchesne, Emery, Grand, and Wayne counties). Winter habitat typically includes areas of open water, adequate food sources, and sufficient diurnal perches and night roosts.	Moderate. Bald eagle winter roosting habitat occurs along the eastern edge of the Project Area in the Green River riparian corridor.	**No. Winter roosts sites are located along the eastern edge of the Project Area.**
Black swift *Cypseloides niger*	S SPC	This species requires waterfalls for nesting; typically the falls are permanent. Coniferous forests, often mixed conifer or spruce-fir forests, typically surround nesting sites, but this varies depending on elevation and aspect, and nest sites may include mountain shrub, aspen, or even alpine components. Streams that create the waterfalls are typically mountain riparian habitats.	None. Suitable habitat for this species does not exist in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Bobolink *Dolichonyx oryzivorus*	S SPC	Inhabits mesic and irrigated meadows, riparian woodlands, and subalpine marshes at lower elevations (2,800–5,500 feet). Suitable breeding habitat includes tall grass, flooded meadows, prairies, and agricultural fields; forbs and perch sites also are required.	Low. The species breeds in isolated areas of Utah, primarily in the northern half of the state. No breeding by this species has been documented in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Burrowing owl *Athene cunicularia*	S SPC	Inhabits desert, semi-desert shrubland, grasslands, and agricultural areas. Nesting habitat primarily consists of flat, dry, and relatively open terrain; short vegetation; and abandoned mammal burrows for nesting and shelter. Breeding season: April through July 15.	Moderate to High. Scattered prairie dog colonies are located in the Project Area which this species may utilize for nesting.	**No. Burrowing owls, nesting sites, and suitable habitat in the Project Area.**
Ferruginous hawk *Buteo regalis*	S SPC	In Utah, this species resides mainly in lowland open desert terrain characterized by barren cliffs and bluffs, pinyon-juniper woodlands, sagebrush-rabbit brush, and cold desert shrub. Nesting habitat includes promontory points and rocky outcrops.	Moderate to High. Suitable foraging and nesting habitat for this species does occur in the Project Area.	**No. This species has been known to nest in the Project Area.**

SPECIES	STATUS[1]	HABITAT ASSOCIATION	POTENTIAL FOR OCCURRENCE WITHIN THE PROPOSED MONUMENT BUTTE PROJECT AREA AND CUMULATIVE EFFECTS AREA	ELIMINATED FROM DETAILED ANALYSIS? (YES/NO)
Golden eagle *Aquilla chysaetos*	BGEPA	Found in mountainous areas, canyons, shrublands, and grasslands, and in shrub-steppe habitats in the winter. Populations in the northern parts of the breeding range migrate south for winter; however, most populations in Utah are year-round residents of the same area. In Utah, this species occurs in nearly all habitats from desert grasslands to mountainous regions. They occur in grass-scrub, shrub-sapling, and young woodland habitats with open lands for nearby hunting. Nests are constructed on cliffs or in large trees. Breeding season generally occurs from February 15 through May 30.	High. Nesting and foraging habitat is found throughout the Project Area.	**No. This species has been known to nest in the Project Area.**
Grasshopper sparrow *Ammodramus savannarum*	S SPC	Prefers grasslands of intermediate height and are often associated with clumped vegetation interspersed with patches of bare ground. Other habitat requirements include moderately-deep litter and sparse coverage of woody vegetation.	Low to Moderate. Breeding populations have been documented in the north portions of the state, including portions of Duchesne and Uintah Counties.	**No. Potential habitat for this species is present in the Project Area.**
Greater sage-grouse *Centrocercus urophasianus*	C	Inhabits upland sagebrush habitat in rolling hills and benches. Breeding occurs on open leks (or strutting grounds) and nesting and brooding occurs in upland areas and meadows in proximity to water and generally within a 1-mile radius of the lek. During winter, sagebrush habitats at submontane elevations commonly are used. Breeding season: March 1 through June 30.	Moderate. The species is widespread, but declining, in Utah, with extant populations in Uintah and Duchesne counties. Habitat has been identified in the Project Area.	**No. Habitat has been identified in the Project Area.**
Lewis's woodpecker *Melanerpes lewis*	S SPC	Inhabits open habitats including pine forests, riparian areas, and piñon-juniper woodlands. Breeding habitat typically includes ponderosa pines and cottonwoods in stream bottoms and farm areas. In Utah, the species inhabits agricultural lands and urban parks, montane and desert riparian woodlands, and submontane shrub habitats. Breeding season: mid-May through mid-August.	Low to Moderate. In Utah, the species is widespread, but is an uncommon nester along the Green River. Breeding by this species has been observed in Ouray in Uintah county, and along Pariette Wash.	**No. Potential habitat for this species may occur in the Project Area.**
Long-billed curlew *Numenius americanus*	S SPC	Inhabits shortgrass prairies, alpine meadows, riparian woodlands, and reservoir habitats. Breeding habitat includes upland areas of shortgrass prairie or grassy meadows with bare ground components, usually near water.	Low. Widespread migrant in Utah. Breeding birds are fairly common but localized, primarily in central and northwestern Utah. Potential nesting has been reported in Uintah County, but has not been confirmed.	**No. Potential habitat for this species may occur in the Project Area.**

SPECIES	STATUS[1]	HABITAT ASSOCIATION	POTENTIAL FOR OCCURRENCE WITHIN THE PROPOSED MONUMENT BUTTE PROJECT AREA AND CUMULATIVE EFFECTS AREA	ELIMINATED FROM DETAILED ANALYSIS? (YES/NO)
Mountain plover *Charadrius montanus*	S SPC	This species is typically associated with shortgrass prairie habitat composed primarily of blue grama and buffalo grass (*Buchloe dactyloides*). However, habitat characteristics in the Uinta Basin are notably different from shortgrass prairie breeding areas. In Utah, this species has been recorded as a casual migrant in Box Elder, Weber, Salt Lake, and Daggett counties. Six (6) documented historical sightings have occurred in the Uinta Basin. One known breeding population that occured in Utah was located on Myton Bench. The Utah population bred in shrub-steppe habitat among white-tailed prairie dogs and near roadways or oil well pads.	Low to Moderate. The breeding population on Myton Bench has declined greatly in recent years. There have been no breeding bird sightings in Utah since 2005.	**No. Potential habitat for this species occurs in the Project Area.**
Northern goshawk *Accipiter gentilis*	S CS	Mature mountain forest and riparian zone habitats. The northern goshawk is a neotropical migrant that occurs across the northern regions of North America in scattered populations primarily in mature mountain forest and valley cottonwood habitats.	None. There is no suitable habitat for this species in the Project Area. Populations of northern goshawk have been identified in the mid elevations in the Uinta Mountains and the Book Cliffs.	Yes. Potential habitat for this species does not occur in the Project Area.
Mexican spotted owl *Strix occidentalis lucida*	T	This species is found primarily in canyons with mixed conifer forests, pine-oak woodlands and riparian areas. This species nests on platforms and large cavities in trees, on ledges, and in caves. Breeding and nesting season: approximately March through August.	None. No Mexican spotted owl suitable habitat or nests have been identified in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Short-eared owl *Asio flammeus*	S SPC	Inhabits arid grasslands, agricultural areas, marshes, and occasionally open woodlands. In Utah, cold desert shrub and sagebrush-rabbit brush habitats also are utilized. Typically a ground nester: April 10 through June 15.	Moderate. The species breeds in northern Utah and occurs as a migrant potentially throughout the state. Known to occur in Uintah County, with occurrence probable in Duchesne County.	**No. Potential habitat for this species occurs in the Project Area.**
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	C	This species is considered to be a riparian obligate and usually occurs in large tracts of cottonwood/willow habitats. However, this species also has been documented in lowland deciduous woodlands, alder thickets, deserted farmlands, and orchards. Breeding season: late June through July.	Low to Moderate Potential. Small patches of potential habitat occur immediately east of the Project Area and breeding has been confirmed at the Ouray National Wildlife Refuge.	**No. Suitable habitat occurs along the Green River east of the Project Area.**

SPECIES	STATUS[1]	HABITAT ASSOCIATION	POTENTIAL FOR OCCURRENCE WITHIN THE PROPOSED MONUMENT BUTTE PROJECT AREA AND CUMULATIVE EFFECTS AREA	ELIMINATED FROM DETAILED ANALYSIS? (YES/NO)
Fish				
Bluehead sucker *Catostomus discobolus*	S CS	Occupies a wide range of aquatic habitats ranging from cold, clear mountain streams to warm, turbid rivers. This species occurs in the lower portion of Pariette Draw and in the Green River below the Pariette Draw confluence. Fast flowing streams have been identified as important habitat for this species.	Moderate. Suitable habitat for this species occurs along portions of the Green River east of the Project Area.	**No. Suitable habitat occurs for this species**
Bonytail *Gila elegans*	E	This species is endemic to the Colorado River system and currently is restricted to the Green River in Utah. They use main channels of large rivers and favor swift currents.	Moderate. Designated Critical Habitat for this species occurs at the segment of the Green River located approximately 20 miles downstream of the Project Area.	**No. Habitat for this species occurs downstream from the Project Area within the Green River.**
Colorado pikeminnow *Ptychocheilus lucius*	E	The range of the Colorado pikeminnow is restricted to the Upper Colorado River basin, upstream of Glen Canyon Dam. Adult Colorado pikeminnow use a variety of habitat types, depending on time of year, but mainly utilize shoreline runs, eddies, backwater habitats, seasonally flooded bottoms, and side canyons. They are most abundant in the upper Green River (between the mouth of the Yampa River and head of Desolation Canyon) and lower Green River (between the Price and San Rafael Rivers). Other concentration areas include the Yampa River, the lower 21 miles of the White River, and the Ruby and Horsethief Canyon area between Westwater, Utah, and Loma, Colorado.	Moderate to High. Critical habitat for this species is located along the Green River that flows through the eastern edge of the Project Area.	**No. Critical habitat is located along the Green River on the eastern edge of the Project Area.**
Flannelmouth sucker *Catostomus latipinnis*	S CS	Adults occur in riffles, runs, and pools in streams and large rivers, with the highest densities usually in pool habitat. Young live in slow to moderately swift waters near the shoreline areas.	Moderate to High. This species occurs in the Green River from the Colorado confluence up to the Flaming Gorge Reservoir.	**No. Habitat for this species occurs in the Green River along the eastern edge of the Project Area.**

SPECIES	STATUS[1]	HABITAT ASSOCIATION	POTENTIAL FOR OCCURRENCE WITHIN THE PROPOSED MONUMENT BUTTE PROJECT AREA AND CUMULATIVE EFFECTS AREA	ELIMINATED FROM DETAILED ANALYSIS? (YES/NO)
Humpback chub *Gila cypha*	E	Suitable habitat for this species is characterized by a wide variety of riverine habitats, especially canyon areas with fast currents, deep pools, and boulder habitat. This species originally inhabited the main stem of the Colorado River from what is now Lake Mead to the canyon areas of the Green and Yampa River Basins. Currently, it appears restricted to the Colorado River at Black Rocks and Westwater Canyon of the Green River, and Yampa Canyon of the Yampa River. Suitable habitat and critical habitat has been designated for this species in the Green River in Uintah County.	Moderate. Designated Critical Habitat for this species occurs along the segment of Green River located approximately 20 miles downstream of the Project Area.	**No. Habitat for this species occurs downstream from the Project Area within the Green River.**
Razorback sucker *Xyrauchen texanus*	E	This fish species is found in a variety of habitats including quiet eddies, pools, and mid-channel runs. They are usually found over sand or silt substrate, but occur over gravel and cobble bars. The largest population is known to occur in the upper Green River between the confluence of the Yampa River and the confluence of the Duchesne River. Adults also occur in the Colorado River near Grand Junction, Colorado, although numbers are very low. Critical habitat has been designated for this species in the Green River in Carbon, Duchesne, Emery, Uintah and Grand Counties.	Moderate to High. Critical habitat for this species is located along the Green River that flows through the eastern edge of the Project Area.	**No. Critical habitat is located along the Green River on the eastern edge of the Project Area.**
Roundtail chub *Gila robusta*	S CS	This species is most often found in murky pools near strong currents in the main-stem Colorado River and its large tributaries. Adults inhabit low to high flow areas in the Green River; young occur in shallow areas with minimal flow.	Moderate. Known distribution of this species includes portions of the Green River along the eastern edge of the Project Area.	**No. Habitat for this species occurs in the Green River along the eastern edge of the Project Area.**
Mammals				
Big free-tailed bat *Nyctinomops macrotis*	S SPC	The species is rare in Utah, occurring primarily in the southern half of the state, although individuals may rarely occur in northern Utah. Prefers rocky and woodland habitats, where roosting occurs in caves, mines, old buildings, and rock crevices.	Moderate. Cliffs that bats may use for roosting occur in the Project Area.	**No. Potential habitat for this species may occur in the Project Area.**
Black-footed ferret *Mustela nigripes*	E	This species inhabits semi-arid grasslands and mountain basins. It is found primarily in association with active prairie dog colonies that contain suitable burrow densities and colonies that are of sufficient size.	None. Suitable habitat is not present.	Yes. Potential habitat for this species does not occur in the Project Area.

SPECIES	STATUS[1]	HABITAT ASSOCIATION	POTENTIAL FOR OCCURRENCE WITHIN THE PROPOSED MONUMENT BUTTE PROJECT AREA AND CUMULATIVE EFFECTS AREA	ELIMINATED FROM DETAILED ANALYSIS? (YES/NO)
Canada lynx *Lynx canadensis*	E	Primarily occurs in Douglas-fir, spruce-fir, and subalpine forests at elevations above 7,800 feet. The lynx uses large woody debris such as downed logs and windfalls to provide denning sites for protection and thermal cover for kittens.	None. If extant in Utah, this species most likely occurs in montane forests in the Uinta Mountains.	Yes. Potential habitat for this species does not occur in the Project Area.
Fringed myotis *Myotis thysanodes*	S SPC	A small bat that occurs in most of the western United States, as well as in much of Mexico and part of southwestern Canada. The species is widely distributed throughout Utah, but is not very common in the state. The fringed myotis inhabits caves, mines, and buildings, most often in desert and woodland areas.	Low. Based on the known range and the presence of suitable habitat, this species has the potential to occur in the Project Area.	**No. Potential habitat for this species occurs in the Project Area.**
Kit fox *Vulpes macrotis*	S SPC	Native to much of the western United States and northern Mexico. Although the species is not overly abundant in Utah, it does occur in the western, east-central, and southeastern areas of the state. The kit fox opportunistically eats small mammals (primarily rabbits and hares), small birds, invertebrates, and plant matter. The species is primarily nocturnal, but individuals may be found outside of their dens during the day. The species most often occurs in open prairie, plains, and desert habitats.	None. Suitable habitat for this species does not exist in the project area.	Yes. Potential habitat for this species does not occur in the Project Area.
Spotted bat *Euderma maculatum*	S SPC	Inhabits desert shrub, sagebrush-rabbitbrush, Pinyon-juniper woodland, and ponderosa pine and montane forest habitats. In Utah, the species also uses lowland riparian and montane grassland habitats. Suitable cliff habitat typically appears to be necessary for roosts/hibernacula. Spotted bats typically do not migrate and use hibernacula that maintain a constant temperature above freezing from September through May. Hibernation (in caves) and winter activity have been documented in southwestern Utah.	Low. The species potentially occurs throughout Utah; however, no occurrence records exist for the extreme northern or western parts of the state. Known occurrences have been reported in northeastern Uintah County.	**No. Potential habitat for this species occurs in the Project Area.**
Townsend's big-eared bat *Corynorhinus townsendii*	S SPC	Inhabits a wide range of habitats from semi desert shrublands and piñon-juniper woodlands to open montane forests. Roosting occurs in mines and caves, in abandoned buildings, on rock cliffs, and occasionally in tree cavities. Foraging occurs well after dark over water, along margins of vegetation, and over sagebrush.	Low. The species occurs throughout much of Utah including Duchesne and Uintah counties. Relative to the project area, one individual was collected at the Ouray National Wildlife Refuge in 1980.	**No. Potential habitat for this species occurs in the Project Area.**

SPECIES	STATUS[1]	HABITAT ASSOCIATION	POTENTIAL FOR OCCURRENCE WITHIN THE PROPOSED MONUMENT BUTTE PROJECT AREA AND CUMULATIVE EFFECTS AREA	ELIMINATED FROM DETAILED ANALYSIS? (YES/NO)
White-tailed prairie dog *Cynomys leucurus*	S SPC	White-tailed prairie dogs are typically found in open shrublands, semi-desert grasslands, and mountain valleys, where they occur in loosely organized colonies that may occupy hundreds of acres on favorable sites. Similar to other prairie dogs, white-tailed prairie dogs spend much of their time in underground burrows, often hibernating during the winter.	High. According to prairie dog colony mapping, approximately 9,372 acres of prairie dog colonies are located in the Project Area.	**No. This species is known to occur in the Project Area.**
Reptiles				
Cornsnake *Elaphe guttata*	S SPC	An isolated population occurs in western Colorado and eastern Utah. Usually found near streams, or in rocky or forest habitats. This species is typically more active at night.	None. Typical habitats for this species do not occur in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Smooth greensnake *Opheodrys vernalis*	S SPC	Typically inhabits meadows, grassy marshes, and moist grassy fields along forest edges. Its distribution ranges from northeastern Utah into central Colorado and northern New Mexico, and into the Northern Plains from the Canadian border south to Kansas and Missouri.	None. Typical habitats for this species do not occur in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.

[1] Status: E = Federally listed as endangered; T = Federally listed as threatened; C = Federal candidate species; P = Federal proposed species; S = BLM sensitive species, Vernal Field Office; SPC = Wildlife species of concern; CS = Species receiving special mgmt. under a Conservation Agreement to preclude the need for Federal listing; BGEPA = Bald and Golden Eagle Protection Act.

Source: Adapted from BLM Vernal Field Office, Special Status Fish and Wildlife Species List (UDWR 2011b).
Source: UNHP-UDWR 2007, UNPS 2007.

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APPENDIX F

Erosion and Sediment Load Estimation

EROSION AND SEDIMENT LOAD ESTIMATION

For the purposes of this analysis, we have defined erosion as the process by which soil particles are mobilized and sediment load is the amount of eroded material that enters a stream channel. Sediment delivery ratio is the fraction of eroded material that enters a stream as the sediment load. While erosion can occur due to the action of wind, water, or glaciers, the Soils and Water Resources sections of this report are primarily concerned with erosion caused by water. Erosion was assumed to occur from four sources: 1) general soil erosion occurring throughout the watersheds, 2) well pads and facilities, 3) roads at stream crossings, and 4) roads throughout the remainder of the MBPA. The sediment load was assumed to occur from three sources: 1) general soil erosion occurring throughout the watersheds, 2) well pads and facilities, and 3) roads at stream crossings. It was assumed that sediment eroded from roads that were greater than 300 feet from a stream did not reach the stream and therefore, was not considered as a sediment load to the stream.

General soil erosion was estimate by acquiring sediment yield coefficients from a literature search on studies that were performed in northeast Utah. From these studies, we were able to estimate the sediment yield from combinations of vegetation and soil erodibility. The vegetation types were obtained from vegetation maps discussed in **Section 3.7** of this EIS. Soil erodibility categories (Low, Medium, and High) were generated from Water Erosion Potential values obtained from the Natural Resources Conservation Service (NRCS) GIS database. While sediment yield is a measure of the quantity of soil delivered to a watershed's stream, in this case we are also assuming that the watershed's sediment yield is also the amount of erosion occurring in the watershed. **Table F-1** provides a list of the sediment yield coefficients used in the analysis. **Tables F-2** through **F-5** show the general watershed erosion and sediment load occurring in each watershed.

Table F-1. Sediment Yield Coefficient

Land Cover	Soil Erodibility	Sediment Yield Coefficient (acre-feet/sq.mi./year)
Pinyon Juniper	Low	0.2
Riparian	Low	0.1
Sagebrush	Low	0.3
Desert Shrub	Low	0.4
Badlands	Low	0.5
Pinyon Juniper	Medium	0.4
Riparian	Medium	0.2
Sagebrush	Medium	0.6
Desert Shrub	Medium	0.9
Badlands	Medium	1.2
Pinyon Juniper	High	0.7
Riparian	High	0.3
Sagebrush	High	1.0
Desert Shrub	High	1.5
Badlands	High	2.0
Water or Rock	-	0.0

Table F-2. Erosion and Sediment Yield from General Erosion for Antelope Creek Watershed

Land Cover	Soil Erodibility	Area (acres)	Sediment Yield Coefficient (acre-feet/sq.mi./year)	Sediment Yield (tons/year)	Delivery Ratio	Erosion (tons/year)
Pinyon Juniper	Low	-	0.2	0	100%	0
Riparian	Low	-	0.1	0	100%	0
Sagebrush	Low	35	0.3	32	100%	32
Desert Shrub	Low	105	0.4	129	100%	129
Badlands	Low	-	0.5	0	100%	0
Pinyon Juniper	Medium	-	0.4	0	100%	0
Riparian	Medium	-	0.2	0	100%	0
Sagebrush	Medium	-	0.6	0	100%	0
Desert Shrub	Medium	10	0.9	28	100%	28
Badlands	Medium	-	1.2	0	100%	0
Pinyon Juniper	High	-	0.7	0	100%	0
Riparian	High	-	0.3	0	100%	0
Sagebrush	High	-	1.0	0	100%	0
Desert Shrub	High	-	1.5	0	100%	0
Badlands	High	-	2.0	0	100%	0
Water or Rock	-	-	0.0	0	100%	0
Total	**-**	**151**	**-**	**189**	**-**	**189**

Assume that soil density is 90 lbs. per cubic foot.

Table F-3. Erosion and Sediment Yield from General Erosion for Upper Pariette Draw Watershed

Land Cover	Soil Erodibility	Area (acres)	Adjusted Area (1) (acres)	Sediment Yield Coefficient (acre-feet/sq.mi./year)	Sediment Yield (tons/year)	Delivery Ratio	Erosion (tons/year)
Pinyon Juniper	Low	3,847	3,847	0.2	2,356	100%	2,356
Riparian	Low	-	-	0.1	0	100%	0
Sagebrush	Low	14,032	14,032	0.3	12,893	100%	12,893
Desert Shrub	Low	11,011	11,011	0.4	13,490	100%	13,490
Badlands	Low	914	914	0.5	1,400	100%	1,400
Pinyon Juniper	Medium	0	0	0.4	0	100%	0
Riparian	Medium	-	-	0.2	0	100%	0
Sagebrush	Medium	1,060	1,060	0.6	1,949	100%	1,949
Desert Shrub	Medium	9,874	9,874	0.9	27,217	100%	27,217
Badlands	Medium	19	19	1.2	72	100%	72
Pinyon Juniper	High	-	-	0.7	0	100%	0
Riparian	High	-	-	0.3	0	100%	0
Sagebrush	High	-	-	1.0	0	100%	0
Desert Shrub	High	22	22	1.5	102	100%	102
Badlands	High	-	-	2.0	0	100%	0
Water or Rock	-	-	65	0.0	0	100%	0
Total	**-**	**40,780**	**40,845**	**-**	**59,479**	**-**	**59,479**

(1) The individual areas did not sum to the total area of the watershed so the areas were adjusted.
Assume that soil density is 90 lbs. per cubic foot.

Table F-4. Erosion and Sediment Yield from General Erosion for Sheep Wash-Green River Watershed

Land Cover	Soil Erodibility	Area (acres)	Adjusted Area (1) (acres)	Sediment Yield Coefficient (acre-feet/sq.mi./year)	Sediment Yield (tons/year)	Delivery Ratio	Erosion (tons/year)
Pinyon Juniper	Low	-	-	0.2	0	100%	0
Riparian	Low	3	3	0.1	1	100%	1
Sagebrush	Low	338	338	0.3	311	100%	311
Desert Shrub	Low	3,384	3,384	0.4	4,146	100%	4,146
Badlands	Low	398	398	0.5	610	100%	610
Pinyon Juniper	Medium	-	-	0.4	0	100%	0
Riparian	Medium	13	13	0.2	8	100%	8
Sagebrush	Medium	63	63	0.6	116	100%	116
Desert Shrub	Medium	6,336	6,336	0.9	17,466	100%	17,466
Badlands	Medium	46	46	1.2	170	100%	170
Pinyon Juniper	High	-	-	0.7	0	100%	0
Riparian	High	-	-	0.3	0	100%	0
Sagebrush	High	-	-	1.0	0	100%	0
Desert Shrub	High	-	-	1.5	0	100%	0
Badlands	High	-	-	2.0	0	100%	0
Water or Rock	-	14	35	0.0	0	100%	0
Total	**-**	**10,596**	**10,617**	**-**	**22,827**	**-**	**22,827**

(1) The individual areas did not sum to the total area of the watershed so the areas were adjusted.
Assume that soil density is 90 lbs. per cubic foot.

Table F-5. Erosion and Sediment Yield from General Erosion for Lower Pariette Draw Watershed

Land Cover	Soil Erodibility	Area (acres)	Adjusted Area (1) (acres)	Sediment Yield Coefficient (acre-feet/sq.mi./year)	Sediment Yield (tons/year)	Delivery Ratio	Erosion (tons/year)
Pinyon Juniper	Low	2	2	0.2	1	100%	1
Riparian	Low	-	-	0.1	0	100%	0
Sagebrush	Low	19,137	19,137	0.3	17,584	100%	17,584
Desert Shrub	Low	16,908	16,908	0.4	20,714	100%	20,714
Badlands	Low	2,329	2,329	0.5	3,567	100%	3,567
Pinyon Juniper	Medium	-	-	0.4	0	100%	0
Riparian	Medium	-	-	0.2	0	100%	0
Sagebrush	Medium	1,742	1,742	0.6	3,201	100%	3,201
Desert Shrub	Medium	27,255	27,255	0.9	75,130	100%	75,130
Badlands	Medium	555	555	1.2	2,039	100%	2,039
Pinyon Juniper	High	-	-	0.7	0	100%	0
Riparian	High	-	-	0.3	0	100%	0
Sagebrush	High	-	-	1.0	0	100%	0
Desert Shrub	High	-	-	1.5	0	100%	0
Badlands	High	-		2.0	0	100%	0
Water or Rock	-	148	202	0.0	0	100%	0
Total	-	**68,077**	**68,131**	-	**122,237**	-	**122,237**

(1) The individual areas did not sum to the total area of the watershed so the areas were adjusted.
Assume that soil density is 90 lbs. per cubic foot.

Created by the NRCS, the Revised Universal Soil Loss Equation 2 (RUSLE2) computer program was used to estimate erosion from well pads. A typical well pad configuration was developed. Each well pad was assumed to be 475 feet long by 225 feet wide with a one percent slope. There was assumed to be five-foot high cut slope at a 3:1 slope at one end and a five-foot high fill slope at a 3:1 slope at the other end. The erosion from the pad was estimated for pads located on the four soil types found in the GMPA: loam, silt loam, sandy loam, and clay loam. It was assumed that all pads were constructed using the required erosion and sediment control Best Management Practices (BMPs), including a berm along the top edge of the pad and a sedimentation basin to capture sediment before it leaves the site. The RUSLE2 program estimated the erosion from the pad and also the reduction of the sediment load due to the BMPs that will be used. The typical pad erosion and sediment load estimate from each soil type was multiplied by the total number of pads located in a particular soil type and in each watershed to obtain an estimate of the erosion and sediment load in each watershed.

In addition, some existing pads will be expanded. It was assumed that the typical pad expansion would be about 0.2 acres or about 10 percent of the area of a new pad. It was assumed that the erosion and sediment load rate was proportional to the area of the pad; therefore, the erosion and sediment load from the portion of the new expanded pad was assumed to be 10 percent of a new pad. It was assumed that there would be no erosion or sediment load from existing pads because they would have undergone interim reclamation. Disturbed areas would have either been revegetated or graveled, so there would essentially be no erosion from the site. **Tables F-6** through **F-9** provide the estimated erosion and sediment load from well pads in each watershed.

Table F-6. Sediment Yield from Pad Erosion per Watershed for Alternative A

Watershed	Soil Type	# of New Pads	# of Expanded Pads	Erosion per Pad for New Pads (1) (tons/year)	Erosion per Pad for Expanded Pads (2) (tons/year)	Length of Construction and Development Phase (years)	Erosion (3) (tons/year)	Sediment Delivery From Each New Pad (tons/year)	Sediment Delivery From Each Expanded Pad (tons/year)	Total Sediment Delivery from Pads (tons/year)	Delivery Ratio To Stream (4)	Sediment Yield To Stream (tons/year)
Antelope Creek	Loam	0	0	0.044	0.0044	16	0.00	0.0019	0.0002	0.0000	0.1	0.000
Antelope Creek	Clay Loam	0	0	0.024	0.0024	16	0.00	0.0019	0.0002	0.0000	0.1	0.000
Antelope Creek	Silty Loam	0	0	0.059	0.0059	16	0.00	0.0029	0.0003	0.0000	0.1	0.000
Antelope Creek	Sandy Loam	4		0.039	0.0039	16	0.01	0.0010	0.0001	0.0003	0.1	0.000
Subtotal		4	0				0.01			0.0003		0.000
Lower Pariette Draw	Loam	185	166	0.044	0.0044	16	0.55	0.0019	0.0002	0.0243	0.1	0.002
Lower Pariette Draw	Clay Loam	18	19	0.024	0.0024	16	0.03	0.0019	0.0002	0.0023	0.1	0.000
Lower Pariette Draw	Silty Loam	108	49	0.059	0.0059	16	0.41	0.0029	0.0003	0.0207	0.1	0.002
Lower Pariette Draw	Sandy Loam	405	546	0.039	0.0039	16	1.12	0.0010	0.0001	0.0288	0.1	0.003
Subtotal		716	780				2.12			0.0761		0.008
Sheep Wash-Green River	Loam	51	3	0.044	0.0044	16	0.14	0.0019	0.0002	0.0062	0.1	0.001
Sheep Wash-Green River	Clay Loam	19	8	0.024	0.0024	16	0.03	0.0019	0.0002	0.0023	0.1	0.000
Sheep Wash-Green River	Silty Loam	34	7	0.059	0.0059	16	0.13	0.0029	0.0003	0.0064	0.1	0.001
Sheep Wash-Green River	Sandy Loam	98	11	0.039	0.0039	16	0.24	0.0010	0.0001	0.0062	0.1	0.001
Subtotal		202	29				0.54			0.0211		0.002
Upper Pariette Draw	Loam	68	101	0.044	0.0044	16	0.21	0.0019	0.0002	0.0094	0.1	0.001
Upper Pariette Draw	Clay Loam	5	6	0.024	0.0024	16	0.01	0.0019	0.0002	0.0007	0.1	0.000
Upper Pariette Draw	Silty Loam	26	31	0.059	0.0059	16	0.11	0.0029	0.0003	0.0053	0.1	0.001
Upper Pariette Draw	Sandy Loam	302	457	0.039	0.0039	16	0.85	0.0010	0.0001	0.0218	0.1	0.002
Subtotal		401	595				1.18			0.0372		0.004
Total		**1323**	**1404**				**3.85**			**0.1346**		**0.013**

(1) Assumes that typical pad area size is 2.45 acres
(2) Assumes that expanded area is about 10% of the new pad area so erosion is 10% that of new pad.
(3) Assumes that 1/16th of the total number of wells are constructed each year during the construction and development phase and that each well pad is "disturbed" for one (1) year until it is reclaimed and additional erosion over background erosion ceases.
(4) Assumes that 10% of the sediment leaving the pad site is delivered to a stream.
One pad location is located on 'No Soil'.

Table F-7. Sediment Yield from Pad Erosion per Watershed for Alternative B

Watershed	Soil Type	# of New Pads	# of Expanded Pads	Erosion per Pad for New Pads (1) (tons/year)	Erosion per Pad for Expanded Pads (2) (tons/year)	Length of Construction and Development Phase (years)	Erosion (3) (tons/year)	Sediment Delivery From Each New Pad (tons/year)	Sediment Delivery From Each Expanded Pad (tons/year)	Total Sediment Delivery from Pads (tons/year)	Delivery Ratio To Stream (4)	Sediment Yield To Stream (tons/year)
Antelope Creek	Loam	0	0	0.044	0.0044	16	0.00	0.0019	0.0002	0.0000	0.1	0.000
Antelope Creek	Clay Loam	0	0	0.024	0.0024	16	0.00	0.0019	0.0002	0.0000	0.1	0.000
Antelope Creek	Silty Loam	0	0	0.059	0.0059	16	0.00	0.0029	0.0003	0.0000	0.1	0.000
Antelope Creek	Sandy Loam	0	0	0.039	0.0039	16	0.00	0.0010	0.0001	0.0000	0.1	0.000
Subtotal		0	0				0.00			0.0000		0.000
Lower Pariette Draw	Loam	25	10	0.044	0.0044	16	0.07	0.0019	0.0002	0.0031	0.1	0.000
Lower Pariette Draw	Clay Loam	10	10	0.024	0.0024	16	0.02	0.0019	0.0002	0.0013	0.1	0.000
Lower Pariette Draw	Silty Loam	2	2	0.059	0.0059	16	0.01	0.0029	0.0003	0.0004	0.1	0.000
Lower Pariette Draw	Sandy Loam	71	95	0.039	0.0039	16	0.20	0.0010	0.0001	0.0050	0.1	0.001
Subtotal		108	117				0.29			0.0099		0.001
Sheep Wash-Green River	Loam	7		0.044	0.0044	16	0.02	0.0019	0.0002	0.0008	0.1	0.000
Sheep Wash-Green River	Clay Loam			0.024	0.0024	16	0.00	0.0019	0.0002	0.0000	0.1	0.000
Sheep Wash-Green River	Silty Loam			0.059	0.0059	16	0.00	0.0029	0.0003	0.0000	0.1	0.000
Sheep Wash-Green River	Sandy Loam	12		0.039	0.0039	16	0.03	0.0010	0.0001	0.0008	0.1	0.000
Subtotal		19	0				0.05			0.0016		0.000
Upper Pariette Draw	Loam	38	23	0.044	0.0044	16	0.11	0.0019	0.0002	0.0049	0.1	0.000
Upper Pariette Draw	Clay Loam	3	3	0.024	0.0024	16	0.00	0.0019	0.0002	0.0004	0.1	0.000
Upper Pariette Draw	Silty Loam	0	7	0.059	0.0059	16	0.00	0.0029	0.0003	0.0001	0.1	0.000
Upper Pariette Draw	Sandy Loam	36	64	0.039	0.0039	16	0.10	0.0010	0.0001	0.0027	0.1	0.000
Subtotal		77	97				0.22			0.0080		0.001
Total		**204**	**214**				**0.56**			**0.0195**		**0.002**

(1) Assumes that typical pad area size is 2.45 acres
(2) Assumes that expanded area is about 10% of the new pad area so erosion is 10% that of new pad.
(3) Assumes that 1/16th of the total number of wells are constructed each year during the construction and development phase and that each well pad is "disturbed" for one (1) year until it is reclaimed and additional erosion over background erosion ceases.
(4) Assumes that 10% of the sediment leaving the pad site is delivered to a stream.
One pad location is located on 'No Soil'.

Table F-8. Sediment Yield from Pad Erosion per Watershed for Alternative C

Watershed	Soil Type	# of New Pads	# of Expanded Pads	Erosion per Pad for New Pads (1) (tons/year)	Erosion per Pad for Expanded Pads (2) (tons/year)	Length of Construction and Development Phase (years)	Erosion (3) (tons/year)	Sediment Delivery From Each New Pad (tons/year)	Sediment Delivery From Each Expanded Pad (tons/year)	Total Sediment Delivery from Pads (tons/year)	Delivery Ratio To Stream (4)	Sediment Yield To Stream (tons/year)
Antelope Creek	Loam	0	0	0.044	0.0044	16	0.00	0.0019	0.0002	0.0000	0.1	0.000
Antelope Creek	Clay Loam	0	0	0.024	0.0024	16	0.00	0.0019	0.0002	0.0000	0.1	0.000
Antelope Creek	Silty Loam	0	0	0.059	0.0059	16	0.00	0.0029	0.0003	0.0000	0.1	0.000
Antelope Creek	Sandy Loam	4		0.039	0.0039	16	0.01	0.0010	0.0001	0.0003	0.1	0.000
Subtotal		4	0				0.01			0.0003		0.000
Lower Pariette Draw	Loam	185	166	0.044	0.0044	16	0.55	0.0019	0.0002	0.0243	0.1	0.002
Lower Pariette Draw	Clay Loam	18	19	0.024	0.0024	16	0.03	0.0019	0.0002	0.0023	0.1	0.000
Lower Pariette Draw	Silty Loam	108	49	0.059	0.0059	16	0.41	0.0029	0.0003	0.0207	0.1	0.002
Lower Pariette Draw	Sandy Loam	405	546	0.039	0.0039	16	1.12	0.0010	0.0001	0.0288	0.1	0.003
Subtotal		716	780				2.12			0.0761		0.008
Sheep Wash-Green River	Loam	51	3	0.044	0.0044	16	0.14	0.0019	0.0002	0.0062	0.1	0.001
Sheep Wash-Green River	Clay Loam	19	8	0.024	0.0024	16	0.03	0.0019	0.0002	0.0023	0.1	0.000
Sheep Wash-Green River	Silty Loam	34	7	0.059	0.0059	16	0.13	0.0029	0.0003	0.0064	0.1	0.001
Sheep Wash-Green River	Sandy Loam	98	11	0.039	0.0039	16	0.24	0.0010	0.0001	0.0062	0.1	0.001
Subtotal		202	29				0.54			0.0211		0.002
Upper Pariette Draw	Loam	68	101	0.044	0.0044	16	0.21	0.0019	0.0002	0.0094	0.1	0.001
Upper Pariette Draw	Clay Loam	5	6	0.024	0.0024	16	0.01	0.0019	0.0002	0.0007	0.1	0.000
Upper Pariette Draw	Silty Loam	26	31	0.059	0.0059	16	0.11	0.0029	0.0003	0.0053	0.1	0.001
Upper Pariette Draw	Sandy Loam	302	457	0.039	0.0039	16	0.85	0.0010	0.0001	0.0218	0.1	0.002
Subtotal		401	595				1.18			0.0372		0.004
Total		**1323**	**1404**				**3.85**			**0.1346**		**0.013**

(1) Assumes that typical pad area size is 2.45 acres
(2) Assumes that expanded area is about 10% of the new pad area so erosion is 10% that of new pad.
(3) Assumes that 1/16th of the total number of wells are constructed each year during the construction and development phase and that each well pad is "disturbed" for one (1) year until it is reclaimed and additional erosion over background erosion ceases.
(4) Assumes that 10% of the sediment leaving the pad site is delivered to a stream.
One pad location is located on 'No Soil'.

Table F-9. Sediment Yield from Pad Erosion per Watershed for Alternative D

Watershed	Soil Type	# of New Pads	# of Expanded Pads	Erosion per Pad for New Pads (1) (tons/year)	Erosion per Pad for Expanded Pads (2) (tons/year)	Length of Construction and Development Phase (years)	Erosion (3) (tons/year)	Sediment Delivery From Each New Pad (tons/year)	Sediment Delivery From Each Expanded Pad (tons/year)	Total Sediment Delivery from Pads (tons/year)	Delivery Ratio To Stream (4)	Sediment Yield To Stream (tons/year)
Antelope Creek	Loam	0	0	0.044	0.0044	16	0.00	0.0019	0.0002	0.0000	0.1	0.0000
Antelope Creek	Clay Loam	0	0	0.024	0.0024	16	0.00	0.0019	0.0002	0.0000	0.1	0.0000
Antelope Creek	Silty Loam	0	0	0.059	0.0059	16	0.00	0.0029	0.0003	0.0000	0.1	0.0000
Antelope Creek	Sandy Loam	4	0	0.039	0.0039	16	0.01	0.0010	0.0001	0.0003	0.1	0.0000
Subtotal		4	0				0.01			0.0003		0.0000
Lower Pariette Draw	Loam	190	194	0.044	0.0044	16	0.58	0.0019	0.0002	0.0253	0.1	0.0025
Lower Pariette Draw	Clay Loam	18	16	0.024	0.0024	16	0.03	0.0019	0.0002	0.0023	0.1	0.0002
Lower Pariette Draw	Silty Loam	96	61	0.059	0.0059	16	0.37	0.0029	0.0003	0.0187	0.1	0.0019
Lower Pariette Draw	Sandy Loam	395	625	0.039	0.0039	16	1.12	0.0010	0.0001	0.0286	0.1	0.0029
Subtotal		699	896				2.10			0.0749		0.0075
Sheep Wash-Green River	Loam	58	4	0.044	0.0044	16	0.16	0.0019	0.0002	0.0070	0.1	0.0007
Sheep Wash-Green River	Clay Loam	22	8	0.024	0.0024	16	0.03	0.0019	0.0002	0.0027	0.1	0.0003
Sheep Wash-Green River	Silty Loam	32	7	0.059	0.0059	16	0.12	0.0029	0.0003	0.0060	0.1	0.0006
Sheep Wash-Green River	Sandy Loam	120	11	0.039	0.0039	16	0.30	0.0010	0.0001	0.0076	0.1	0.0008
Subtotal		232	30				0.61			0.0233		0.0023
Upper Pariette Draw	Loam	25	109	0.044	0.0044	16	0.10	0.0019	0.0002	0.0043	0.1	0.0004
Upper Pariette Draw	Clay Loam	4	4	0.024	0.0024	16	0.01	0.0019	0.0002	0.0005	0.1	0.0001
Upper Pariette Draw	Silty Loam	18	35	0.059	0.0059	16	0.08	0.0029	0.0003	0.0039	0.1	0.0004
Upper Pariette Draw	Sandy Loam	262	463	0.039	0.0039	16	0.75	0.0010	0.0001	0.0193	0.1	0.0019
Subtotal		309	611				0.94			0.0281		0.0028
Total		**1244**	**1537**				**3.65**			**0.1265**		**0.0127**

(1) Assumes that typical pad area size is 2.45 acres
(2) Assumes that expanded area is about 10% of the new pad area so erosion is 10% that of new pad.
(3) Assumes that 1/16th of the total number of wells are constructed each year during the construction and development phase and that each well pad is “disturbed” for one (1) year until it is reclaimed and additional erosion over background erosion ceases.
(4) Assumes that 10% of the sediment leaving the pad site is delivered to a stream.
One pad location is located on ‘No Soil’.

Developed by the U.S. Forest Service, the Water Erosion Prediction Project (WEPP) Road model was used to estimate erosion and the sediment load from dirt roads and at road stream crossings. A sample of road stream crossings were randomly chosen for each type of soil, and the longitudinal slope and width of the road at each sample crossing was measured. It was assumed that erosion from the road occurred within 300 feet of each side of the stream and that 100 percent of the eroded material entered the stream (erosion=sediment load). Road traffic also influences the rate of erosion and sediment load. It was assumed that during the construction and development phase of well construction, road traffic would be “low,” and that during the production phase, road traffic would be “none.” The program was developed for forest service logging roads. Consequently, the use values are relative to what may occur on a typical logging road on forest service land. The erosion and sediment load was calculated at each location using WEPP Roads, and the results were averaged to provide an average erosion and sediment load at a crossing located in each type of soil. These average erosion and sediment load estimates were then multiplied by the number of crossings in each soil type in each watershed to estimate the erosion and sediment contribution from road stream crossings. **Table F-10** contains the erosion and sediment load estimates for existing conditions. **Tables F-11** through **F-14** supply the erosion and sediment load estimates during the construction and development phase for each alternative. **Tables F-15** through **F-18** provide the erosion and sediment load estimates during the production phase for each alternative.

Table F-10. Sediment Yield from Stream Crossing Erosion for Existing Conditions

Watershed	Soil Texture	# of Stream Crossings	Erosion per Crossing (lbs/year)	Erosion (tons/year)	Delivery Ratio	Sediment Yield (tons/year)
Antelope Creek	Clay Loam	0	38.2	0.0	1	0.0
Antelope Creek	Loam	0	84.3	0.0	1	0.0
Antelope Creek	Sandy Loam	0	33.5	0.0	1	0.0
Antelope Creek	Silt Loam	0	279.2	0.0	1	0.0
Subtotal		0		0.0		0.0
Lower Pariette Draw	Clay Loam	25	38.2	0.5	1	0.5
Lower Pariette Draw	Loam	117	84.3	4.9	1	4.9
Lower Pariette Draw	Sandy Loam	247	33.5	4.1	1	4.1
Lower Pariette Draw	Silt Loam	38	279.2	5.3	1	5.3
Subtotal		427		14.9		14.9
Sheep Wash-Green River	Clay Loam	3	38.2	0.1	1	0.1
Sheep Wash-Green River	Loam	3	84.3	0.1	1	0.1
Sheep Wash-Green River	Sandy Loam	18	33.5	0.3	1	0.3
Sheep Wash-Green River	Silt Loam	10	279.2	1.4	1	1.4
Subtotal		34		1.9		1.9
Upper Pariette Draw	Clay Loam	14	38.2	0.3	1	0.3
Upper Pariette Draw	Loam	81	84.3	3.4	1	3.4
Upper Pariette Draw	Sandy Loam	179	33.5	3.0	1	3.0
Upper Pariette Draw	Silt Loam	11	279.2	1.5	1	1.5
Subtotal		285		8.2		8.2
Total		746		24.9		24.9

Note: It is assumed that the existing wells are in the production phase, so road use is negligible.
Assume that soil density is 90 lbs. per cubic foot.

Table F-11: Sediment Yield at Stream Crossing for Alternative A - Construction and Development Phase

Watershed	Soil Texture	# of Stream Crossings	Erosion per Crossing (lbs/year)	Erosion (tons/year)	Delivery Ratio	Sediment Yield (tons/year)
Antelope Creek	Clay Loam	0	128.0	0.0	1	0.0
Antelope Creek	Loam	0	212.3	0.0	1	0.0
Antelope Creek	Sandy Loam	0	48.8	0.0	1	0.0
Antelope Creek	Silt Loam	0	477.4	0.0	1	0.0
Subtotal		0		0.0		0.0
Lower Pariette Draw	Clay Loam	29	128.0	1.9	1	1.9
Lower Pariette Draw	Loam	133	212.3	14.1	1	14.1
Lower Pariette Draw	Sandy Loam	344	48.8	8.4	1	8.4
Lower Pariette Draw	Silt Loam	50	477.4	11.9	1	11.9
Subtotal		556		36.3		36.3
Sheep Wash-Green River	Clay Loam	7	128.0	0.4	1	0.4
Sheep Wash-Green River	Loam	10	212.3	1.1	1	1.1
Sheep Wash-Green River	Sandy Loam	30	48.8	0.7	1	0.7
Sheep Wash-Green River	Silt Loam	16	477.4	3.8	1	3.8
Subtotal		63		6.1		6.1
Upper Pariette Draw	Clay Loam	15	128.0	1.0	1	1.0
Upper Pariette Draw	Loam	96	212.3	10.2	1	10.2
Upper Pariette Draw	Sandy Loam	208	48.8	5.1	1	5.1
Upper Pariette Draw	Silt Loam	15	477.4	3.6	1	3.6
Subtotal		334		19.8		19.8
Total		953		62.2		62.2

Assume that soil density is 90 lbs. per cubic foot.

Table F-12: Sediment Yield at Stream Crossing for Alternative B - Construction and Development Phase

Watershed	Soil Texture	# of Stream Crossings	Erosion per Crossing (lbs/year)	Erosion (tons/year)	Delivery Ratio	Sediment Yield (tons/year)
Antelope Creek	Clay Loam	0	128.0	0.0	1	0.0
Antelope Creek	Loam	0	212.3	0.0	1	0.0
Antelope Creek	Sandy Loam	0	48.8	0.0	1	0.0
Antelope Creek	Silt Loam	0	477.4	0.0	1	0.0
Subtotal		0		0.0		0.0
Lower Pariette Draw	Clay Loam	26	128.0	1.7	1	1.7
Lower Pariette Draw	Loam	129	212.3	13.7	1	13.7
Lower Pariette Draw	Sandy Loam	273	48.8	6.7	1	6.7
Lower Pariette Draw	Silt Loam	38	477.4	9.1	1	9.1
Subtotal		466		31.1		31.1
Sheep Wash-Green River	Clay Loam	3	128.0	0.2	1	0.2
Sheep Wash-Green River	Loam	4	212.3	0.4	1	0.4
Sheep Wash-Green River	Sandy Loam	22	48.8	0.5	1	0.5
Sheep Wash-Green River	Silt Loam	10	477.4	2.4	1	2.4
Subtotal		39		3.5		3.5
Upper Pariette Draw	Clay Loam	15	128.0	1.0	1	1.0
Upper Pariette Draw	Loam	94	212.3	10.0	1	10.0
Upper Pariette Draw	Sandy Loam	182	48.8	4.4	1	4.4
Upper Pariette Draw	Silt Loam	11	477.4	2.6	1	2.6
Subtotal		302		18.0		18.0
Total		807		52.6		52.6

Assume that soil density is 90 lbs. per cubic foot.

Table F-13: Sediment Yield at Stream Crossing for Alternative C - Construction and Development Phase

Watershed	Soil Texture	# of Stream Crossings	Erosion per Crossing (lbs/year)	Erosion (tons/year)	Delivery Ratio	Sediment Yield (tons/year)
Antelope Creek	Clay Loam	0	128.0	0.0	1	0.0
Antelope Creek	Loam	0	212.3	0.0	1	0.0
Antelope Creek	Sandy Loam	0	48.8	0.0	1	0.0
Antelope Creek	Silt Loam	0	477.4	0.0	1	0.0
Subtotal		0		0.0		0.0
Lower Pariette Draw	Clay Loam	29	128.0	1.9	1	1.9
Lower Pariette Draw	Loam	133	212.3	14.1	1	14.1
Lower Pariette Draw	Sandy Loam	344	48.8	8.4	1	8.4
Lower Pariette Draw	Silt Loam	50	477.4	11.9	1	11.9
Subtotal		556		36.3		36.3
Sheep Wash-Green River	Clay Loam	7	128.0	0.4	1	0.4
Sheep Wash-Green River	Loam	10	212.3	1.1	1	1.1
Sheep Wash-Green River	Sandy Loam	30	48.8	0.7	1	0.7
Sheep Wash-Green River	Silt Loam	16	477.4	3.8	1	3.8
Subtotal		63		6.1		6.1
Upper Pariette Draw	Clay Loam	15	128.0	1.0	1	1.0
Upper Pariette Draw	Loam	96	212.3	10.2	1	10.2
Upper Pariette Draw	Sandy Loam	208	48.8	5.1	1	5.1
Upper Pariette Draw	Silt Loam	15	477.4	3.6	1	3.6
Subtotal		334		19.8		19.8
Total		953		62.2		62.2

Assume that soil density is 90 lbs. per cubic foot.

Table F-14: Sediment Yield at Stream Crossing for Alternative D - Construction and Development Phase

Watershed	Soil Texture	# of Stream Crossings	Erosion per Crossing (lbs/year)	Erosion (tons/year)	Delivery Ratio	Sediment Yield (tons/year)
Antelope Creek	Clay Loam	0	128.0	0.0	1	0.0
Antelope Creek	Loam	0	212.3	0.0	1	0.0
Antelope Creek	Sandy Loam	0	48.8	0.0	1	0.0
Antelope Creek	Silt Loam	0	477.4	0.0	1	0.0
Subtotal		0		0.0		0.0
Lower Pariette Draw	Clay Loam	27	128.0	1.7	1	1.7
Lower Pariette Draw	Loam	169	212.3	17.9	1	17.9
Lower Pariette Draw	Sandy Loam	381	48.8	9.3	1	9.3
Lower Pariette Draw	Silt Loam	48	477.4	11.5	1	11.5
Subtotal		625		40.4		40.4
Sheep Wash-Green River	Clay Loam	8	128.0	0.5	1	0.5
Sheep Wash-Green River	Loam	11	212.3	1.2	1	1.2
Sheep Wash-Green River	Sandy Loam	44	48.8	1.1	1	1.1
Sheep Wash-Green River	Silt Loam	13	477.4	3.1	1	3.1
Subtotal		76		5.9		5.9
Upper Pariette Draw	Clay Loam	14	128.0	0.9	1	0.9
Upper Pariette Draw	Loam	95	212.3	10.1	1	10.1
Upper Pariette Draw	Sandy Loam	220	48.8	5.4	1	5.4
Upper Pariette Draw	Silt Loam	16	477.4	3.8	1	3.8
Subtotal		345		20.2		20.2
Total		1046		66.4		66.4

Assume that soil density is 90 lbs. per cubic foot.

Table F-15: Sediment Yield at Stream Crossing for Alternative A - Production Phase

Watershed	Soil Texture	# of Stream Crossings	Erosion per Crossing (lbs/year)	Erosion (tons/year)	Delivery Ratio	Sediment Yield (tons/year)
Antelope Creek	Clay Loam	0	38.2	0.0	1	0.0
Antelope Creek	Loam	0	84.3	0.0	1	0.0
Antelope Creek	Sandy Loam	0	33.5	0.0	1	0.0
Antelope Creek	Silt Loam	0	279.2	0.0	1	0.0
Subtotal		0		0.0		0.0
Lower Pariette Draw	Clay Loam	29	38.2	0.6	1	0.6
Lower Pariette Draw	Loam	133	84.3	5.6	1	5.6
Lower Pariette Draw	Sandy Loam	344	33.5	5.8	1	5.8
Lower Pariette Draw	Silt Loam	50	279.2	7.0	1	7.0
Subtotal		556		18.9		18.9
Sheep Wash-Green River	Clay Loam	7	38.2	0.1	1	0.1
Sheep Wash-Green River	Loam	10	84.3	0.4	1	0.4
Sheep Wash-Green River	Sandy Loam	30	33.5	0.5	1	0.5
Sheep Wash-Green River	Silt Loam	16	279.2	2.2	1	2.2
Subtotal		63		3.3		3.3
Upper Pariette Draw	Clay Loam	15	38.2	0.3	1	0.3
Upper Pariette Draw	Loam	96	84.3	4.0	1	4.0
Upper Pariette Draw	Sandy Loam	208	33.5	3.5	1	3.5
Upper Pariette Draw	Silt Loam	15	279.2	2.1	1	2.1
Subtotal		334		9.9		9.9
Total		953		32.1		32.1

Note: It is assumed that road use will be negligible during the production phase.

Table F-16: Sediment Yield at Stream Crossing for Alternative B - Production Phase

Watershed	Soil Texture	# of Stream Crossings	Erosion per Crossing (lbs/year)	Erosion (tons/year)	Delivery Ratio	Sediment Yield (tons/year)
Antelope Creek	Clay Loam	0	38.2	0.0	1	0.0
Antelope Creek	Loam	0	84.3	0.0	1	0.0
Antelope Creek	Sandy Loam	0	33.5	0.0	1	0.0
Antelope Creek	Silt Loam	0	279.2	0.0	1	0.0
Subtotal		0		0.0		0.0
Lower Pariette Draw	Clay Loam	26	38.2	0.5	1	0.5
Lower Pariette Draw	Loam	129	84.3	5.4	1	5.4
Lower Pariette Draw	Sandy Loam	273	33.5	4.6	1	4.6
Lower Pariette Draw	Silt Loam	38	279.2	5.3	1	5.3
Subtotal		466		15.8		15.8
Sheep Wash-Green River	Clay Loam	3	38.2	0.1	1	0.1
Sheep Wash-Green River	Loam	4	84.3	0.2	1	0.2
Sheep Wash-Green River	Sandy Loam	22	33.5	0.4	1	0.4
Sheep Wash-Green River	Silt Loam	10	279.2	1.4	1	1.4
Subtotal		39		2.0		2.0
Upper Pariette Draw	Clay Loam	15	38.2	0.3	1	0.3
Upper Pariette Draw	Loam	94	84.3	4.0	1	4.0
Upper Pariette Draw	Sandy Loam	182	33.5	3.0	1	3.0
Upper Pariette Draw	Silt Loam	11	279.2	1.5	1	1.5
Subtotal		302		8.8		8.8
Total		807		26.6		26.6

Note: It is assumed that road use will be negligible during the production phase.

Table F-17: Sediment Yield at Stream Crossing for Alternative C - Production Phase

Watershed	Soil Texture	# of Stream Crossings	Erosion per Crossing (lbs/year)	Erosion (tons/year)	Delivery Ratio	Sediment Yield (tons/year)
Antelope Creek	Clay Loam	0	38.2	0.0	1	0.0
Antelope Creek	Loam	0	84.3	0.0	1	0.0
Antelope Creek	Sandy Loam	0	33.5	0.0	1	0.0
Antelope Creek	Silt Loam	0	279.2	0.0	1	0.0
Subtotal		0		0.0		0.0
Lower Pariette Draw	Clay Loam	29	38.2	0.6	1	0.6
Lower Pariette Draw	Loam	133	84.3	5.6	1	5.6
Lower Pariette Draw	Sandy Loam	344	33.5	5.8	1	5.8
Lower Pariette Draw	Silt Loam	50	279.2	7.0	1	7.0
Subtotal		556		18.9		18.9
Sheep Wash-Green River	Clay Loam	7	38.2	0.1	1	0.1
Sheep Wash-Green River	Loam	10	84.3	0.4	1	0.4
Sheep Wash-Green River	Sandy Loam	30	33.5	0.5	1	0.5
Sheep Wash-Green River	Silt Loam	16	279.2	2.2	1	2.2
Subtotal		63		3.3		3.3
Upper Pariette Draw	Clay Loam	15	38.2	0.3	1	0.3
Upper Pariette Draw	Loam	96	84.3	4.0	1	4.0
Upper Pariette Draw	Sandy Loam	208	33.5	3.5	1	3.5
Upper Pariette Draw	Silt Loam	15	279.2	2.1	1	2.1
Subtotal		334		9.9		9.9
Total		953		32.1		32.1

Note: It is assumed that road use will be negligible during the production phase.

Table F-18: Sediment Yield at Stream Crossing for Alternative D - Production Phase

Watershed	Soil Texture	# of Stream Crossings	Erosion per Crossing (lbs/year)	Erosion (tons/year)	Delivery Ratio	Sediment Yield (tons/year)
Antelope Creek	Clay Loam	0	38.2	0.0	1	0.0
Antelope Creek	Loam	0	84.3	0.0	1	0.0
Antelope Creek	Sandy Loam	0	33.5	0.0	1	0.0
Antelope Creek	Silt Loam	0	279.2	0.0	1	0.0
Subtotal		0		0.0		0.0
Lower Pariette Draw	Clay Loam	27	38.2	0.5	1	0.5
Lower Pariette Draw	Loam	169	84.3	7.1	1	7.1
Lower Pariette Draw	Sandy Loam	381	33.5	6.4	1	6.4
Lower Pariette Draw	Silt Loam	48	279.2	6.7	1	6.7
Subtotal		625		20.7		20.7
Sheep Wash-Green River	Clay Loam	8	38.2	0.2	1	0.2
Sheep Wash-Green River	Loam	11	84.3	0.5	1	0.5
Sheep Wash-Green River	Sandy Loam	44	33.5	0.7	1	0.7
Sheep Wash-Green River	Silt Loam	13	279.2	1.8	1	1.8
Subtotal		76		3.2		3.2
Upper Pariette Draw	Clay Loam	14	38.2	0.3	1	0.3
Upper Pariette Draw	Loam	95	84.3	4.0	1	4.0
Upper Pariette Draw	Sandy Loam	220	33.5	3.7	1	3.7
Upper Pariette Draw	Silt Loam	16	279.2	2.2	1	2.2
Subtotal		345		10.2		10.2
Total		1046		34.1		34.1

Note: It is assumed that road use will be negligible during the production phase.

Erosion from roads outside of the stream crossings were also estimated using WEPP:Road. It was assumed that the roads were "outsloped" and runoff would flow off the side of the road and down the embankment, carrying eroded material with it. As previously mentioned, it was assumed that the eroded material would be deposited at the base of the fill slope and would not be transported to a stream so there was no sediment load generated by this erosion source. **Table F-19** contains the erosion estimate for existing conditions. **Tables F-20** through **F-23** present the erosion estimates for each alternative.

Table F-19. Estimated Road Erosion for Existing Conditions

Soil Texture	Road Width (feet)	Road Slope from Left (%)	Road Length (feet)	Climate Station	Rock %	Road Design	Fill Gradient (%)	Fill Length (feet)	Buffer Gradient (%)	Buffer Length (feet)	Road Surface	Traffic Level	Simulation Period (years)	Unit Erosion (pounds/year/100' of road) Construction and Development Phase	Unit Erosion (pounds/year/100' of road) Production Phase	Total Road Length (100 feet)	Total Erosion (tons/year) Construction and Development Phase	Total Erosion (tons/year) Production Phase
Clay Loam	23.4	0.82%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	9.11	13.42	1,100	5.0	7.4
Loam	22.2	1.48%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	11.38	15.93	7,224	41.1	57.5
Sandy Loam	22.4	4.12%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	4.59	5.97	21,573	49.5	64.4
Silty Loam	27.0	4.60%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	17.61	21.01	2,741	24.1	28.8
TOTAL																	**119.8**	**158.1**

Minimum Road Slope is 0.3%

Table F-20. Estimated Road Erosion for Alternative A

Soil Texture	Road Width (feet)	Road Slope from Left (%)	Road Length (feet)	Climate Station	Rock %	Road Design	Fill Gradient (%)	Fill Length (feet)	Buffer Gradient (%)	Buffer Length (feet)	Road Surface	Traffic Level	Simulation Period (years)	Unit Erosion (pounds/year/100' of road) Construction and Development Phase	Unit Erosion (pounds/year/100' of road) Production Phase	Total Road Length (100 feet)	Total Erosion (tons/year) Construction and Development Phase	Total Erosion (tons/year) Production Phase
Clay Loam	23.4	0.82%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	9.11	13.42	1,513	6.9	10.2
Loam	22.2	1.48%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	11.38	15.93	9,823	55.9	78.2
Sandy Loam	22.4	4.12%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	4.59	5.97	29,822	68.4	89.0
Silty Loam	27.0	4.60%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	17.61	21.01	4,220	37.2	44.3
TOTAL																	**168.4**	**221.7**

Minimum Road Slope is 0.3%

Table F-21. Estimated Road Erosion for Alternative B

Soil Texture	Road Width (feet)	Road Slope from Left (%)	Road Length (feet)	Climate Station	Rock %	Road Design	Fill Gradient (%)	Fill Length (feet)	Buffer Gradient (%)	Buffer Length (feet)	Road Surface	Traffic Level	Simulation Period (years)	Unit Erosion (pounds/year/100' of road) Construction and Development Phase	Unit Erosion (pounds/year/100' of road) Production Phase	Total Road Length (100 feet)	Total Erosion (tons/year) Construction and Development Phase	Total Erosion (tons/year) Production Phase
Clay Loam	23.4	0.82%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	9.11	13.42	1,155	5.3	7.8
Loam	22.2	1.48%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	11.38	15.93	7,751	44.1	61.7
Sandy Loam	22.4	4.12%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	4.59	5.97	22,720	52.1	67.8
Silty Loam	27.0	4.60%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	17.61	21.01	2,751	24.2	28.9
TOTAL																	**125.7**	**166.2**

Minimum Road Slope is 0.3%

Table F-22. Estimated Road Erosion for Alternative C

Soil Texture	Road Width (feet)	Road Slope from Left (%)	Road Length (feet)	Climate Station	Rock %	Road Design	Fill Gradient (%)	Fill Length (feet)	Buffer Gradient (%)	Buffer Length (feet)	Road Surface	Traffic Level	Simulation Period (years)	Unit Erosion (pounds/year/100' of road) Construction and Development Phase	Unit Erosion (pounds/year/100' of road) Production Phase	Total Road Length (100 feet)	Total Erosion (tons/year) Construction and Development Phase	Total Erosion (tons/year) Production Phase
Clay Loam	23.4	0.82%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	9.11	13.42	1,513	6.9	10.2
Loam	22.2	1.48%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	11.38	15.93	9,823	55.9	78.2
Sandy Loam	22.4	4.12%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	4.59	5.97	29,822	68.4	89.0
Silty Loam	27.0	4.60%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	17.61	21.01	4,220	37.2	44.3
TOTAL																	**168.4**	**221.7**

Minimum Road Slope is 0.3%

Table F-23. Estimated Road Erosion for Alternative D

Soil Texture	Road Width (feet)	Road Slope from Left (%)	Road Length (feet)	Climate Station	Rock %	Road Design	Fill Gradient (%)	Fill Length (feet)	Buffer Gradient (%)	Buffer Length (feet)	Road Surface	Traffic Level	Simulation Period (years)	Unit Erosion (pounds/year/100' of road) Construction and Development Phase	Unit Erosion (pounds/year/100' of road) Production Phase	Total Road Length (100 feet)	Total Erosion (tons/year) Construction and Development Phase	Total Erosion (tons/year) Production Phase
Clay Loam	23.4	0.82%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	9.11	13.42	1,478	6.7	9.9
Loam	22.2	1.48%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	11.38	15.93	9,728	55.4	77.5
Sandy Loam	22.4	4.12%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	4.59	5.97	29,413	67.5	87.8
Silty Loam	27.0	4.60%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	17.61	21.01	3,928	34.6	41.3
TOTAL																	**164.2**	**216.5**

Minimum Road Slope is 0.3%

APPENDIX G

Newfield Exploration Company
Greater Monument Butte Unit
Reclamation and Weed Management Plan

INTRODUCTION

The purpose for this document is to amend the previously approved *Newfield Exploration Company Castle Peak and Eight Mile Flat Reclamation and Weed Management Plan* (Newfield 2009) which was written to comply with Instruction Memorandum No. GR-2009-002. This amendment is intended to more accurately comply with revised BLM Instruction Memorandum UTG000-2011-003 regarding BLM adoption of the 2011 revised *Green River District Reclamation Guidelines.* In addition, this amendment more accurately defines Newfield's reclamation techniques and monitoring efforts that have been refined to more adequately address these policy changes. The need of this amendment came from examining recent NEPA analyses and BLM Decision Records that referred to conformance with Newfield's previously referenced plan which is no longer consistent with the current BLM policy.

RELATION TO STATUTES, REGULATIONS, AND GUIDELINES

The proposed reclamation plan amendment is consistent with the following Federal Statutes, Regulations, Guidelines and Decisions:

- Onshore Oil and Gas Order Number 1 Section III.B.4J. *Plans for Surface Reclamation;*
- *Surface Operating Standards for Oil and Gas Exploration and Development* or "Goldbook" (BLM and USFS 2007);
- Standards for Rangeland Health and Guidelines for Grazing Management for BLM Lands in Utah (BLM 1997);
- Green River District Reclamation Guidelines 2011 IM UTG000-2011-003; and
- Record of Decision for Newfield Exploration Company's Castle Peak and Eightmile Flat Oil and Gas Development Environmental Impact Statement (2005).

APPLICABLE AREA

This Reclamation Plan Amendment would apply to BLM lands within the Greater Monument Butte Unit and outlines procedures and measures that would be taken to initiate reclamation on all areas that have been authorized for disturbance applicable to *IM UTG000-2011-003.*

The Green River Reclamation Guidelines define **Interim Reclamation** as ***the minimizing of the footprint of disturbance by reclaiming all portions of the well site not needed for safe production operations. The portions of the well site not needed for operational and safety purposes would be recontoured to a final appearance that blends with the surrounding topography. Topsoil would be spread over these areas. The operator would spread the topsoil over the entire location except where an all-weather surface, access route or turnaround is needed. Production facilities should be clustered or placed offsite to maximize the opportunity for interim reclamation. Any incidental use on interim reclamation may require restoration of damage. This may require recontouring and seeding of the damaged area.***

As oil and gas operations may result in surface disturbing activities beyond those described in the Vernal BLM's **Interim Reclamation** definition, Newfield would like to define their interim reclamation capabilities and limitations as part of this amendment.

Areas of Interim Reclamation Potential

- All pipeline corridors resulting in surface disturbance
- All reserve pits
- Portions of well pads following installation of flowlines that would allow removal of separators, heater-treaters, and/or storage tanks
- Portions of the well pad not needed for workover and production operations (i.e., minimum of 1 ac)

RECLAMATION STRATEGY

In addition to general footprint minimization, the following reclamation actions would be conducted by Newfield to meet the short term goal: (***immediately stabilize disturbed areas and to provide the necessary conditions to achieve the long term goal***); and long term goal: (***facilitate eventual ecosystem reconstruction by returning the land to a safe, stable, and proper functioning condition***); as well as the eight reclamation objectives and associated actions outlined in the 2011 Green River District Reclamation Guidelines.

Objective 1 - Establish a desired self-perpetuating plant community.

The objective is to attain 75% basal cover based on similar undisturbed adjacent native vegetative community, and comprised of desired species and/or seeded species within 5 years of initial reclamation action. Species diversity should approximate the surrounding undisturbed area. For areas that are in poor range condition due to past land management practices, then the species diversity should approximate the site as described in the NRCS Ecological Site description. However if after three (3) growing seasons there is less than 30% of the basal cover based on similar undisturbed native vegetative community, then the Authorized Officer may require additional reclamation efforts.

Seed Mix

In cooperation with the BLM Authorized Officer, Newfield would determine a seed mix for the project area. A diversified selection of native seeds found local to the project area would be used. Locally harvested seed would be sought to the greatest extent possible; however seed selection would largely be influenced by market availability. Non-native species would be used in moderation and mixed in low concentrations with natives to assist in initial plant establishment. All use of non-native seed would be authorized by BLM Authorized Officer.

Seed Storage

Seed would be stored in a cool dry place ensuring proper storage required to keep seed viable. All seed utilized would be tested prior to application to ensure BLM specifications for pure live seed (PLS), purity, noxious weeds, etc. have been met. Seed tags would be provided to the Authorized Officer as requested.

Seed Placement

Proper care would be taken to plant assorted sized seeds to proper depths, usually 5 times the width of the seed. Seed would be placed at the correct depth providing good contact between seed and soil. The correct depth of planting would be deep enough to allow seed to take up water, to protect it from desiccation or birds, and to prevent it from germinating with light rains, yet shallow enough to allow the seedling to reach the surface before depleting food reserves or being attacked by insects or disease.

Seedbed Preparation

Newfield would alleviate compaction for root establishment prior to seeding. Seedbeds would also be constructed to physically hold as much water as possible. Rippers, harrows, disks, chisel plows or similar equipment would be used to loosen soil and alleviate compaction. After loosening to desirable depths and after topsoil is reapplied soils may be imprinted and or pocketed. Pockets create microclimates which protect small emerging seedlings, increase soil holding capacity, and decrease runoff and erosion. Imprinting has been found to be successful in the arid climates of Utah. "Seedling emergence was improved by imprinting compared to drilling in Utah." (Clary and Johnson 1983)

Seeding Method

Various seeding techniques including, broadcasting, broadcast/harrow, broadcast/press, and drilling would be used to place seed to optimal depths. Seeding rates would range from 18 to 20 PLS lbs per acre or as prescribed by BLM Authorized Officer.

Seeding Season

Newfield would apply seed between late fall and early spring depending on moisture, ground temperature, and snow cover. Newfield has proven success with winter seeding. Certain species of seed require early spring/winter application for optimal effectiveness.

Mulching

In some cases, Newfield may apply certified weed free straw and crimped in attempt to capture and hold moisture, stabilize soil, provide organic matter, and protect seed. Newfield may also grow an annual grain to reestablish and stabilize soils in late spring/summer months. Such efforts would combat weed growth, supply subsurface organic matter, oxygenate soil, alleviate compaction, and minimize runoff.

Slopes

Areas in excess of 40% slope or are excessively rocky would be amended as safely as possible. Seed rates would in these areas may be increased as necessary. Seed may be broadcast and covered by harrowing, drag bar, roller, or as determined effective and safe by Newfield and BLM Authorized Officer.

Amendments

If initial reclamation activities are unsuccessful, Newfield would amend soils to meet the long-term goals of restoration. Potential soil amendments may include: topsoil, compost, woodchips, wood-pulp, straw, elemental sulfur or other safe acids, gypsum, fertilizer, slow release fertilizer, humus, or any other amendments which prove effective in combating saline/sodic soil characteristics typical of harsh western desert environments.

As determined and in cooperation with the BLM Authorized Officer, fencing may be used to exclude livestock/big game grazing until seeded species have become established. Fencing would be constructed to BLM standards.

Objective 2 - Ensure slope stability and topographic diversity

Newfield would reconstruct disturbed areas to the approximate original contour or to assure the site looks natural or blends with the surrounding terrain.

Where applicable, Newfield would imprint, step down, or lesson slope on steep terrain in effort to control erosion. Perimeter berms may be used on well pads to control site rainwater runoff erosion of site fill material. Summer grown mulch and imprinting may also be considered to help control erosion while simultaneously competing against weeds between desirable seeding windows.

Objective 3 - Reconstruct and stabilize altered water courses and drainage features

Newfield would reconstruct drainage basins to have similar features and hydraulic characteristics found in nearby properly functioning drainages. Pads would be designed to divert water flow around, to keep water off, and to redirect the water back into the established natural watercourse.

Objective 4 - Ensure the biological, chemical, and physical integrity of the topsoil resource during all phases of construction, operation, and reclamation.

BMP's designed to minimize and prevent erosion, compaction, and contamination of the topsoil resource should be used to maintain the topsoil resource.

Topsoil Stripping/Storage

Prior to excavation of subsoil all topsoil would be stripped. Topsoil would be windrowed parallel to disturbance and great care would be taken to segregate topsoil from subsoils. During topsoil stockpiling Newfield would avoid slopes, natural drainage ways, and traffic routes. All topsoil stored beyond one season would be gently compacted to an acceptable height to ensure viability and imprinted/mulched and seeded to reduce erosion and to ensure the long-term viability of the resource. Newfield would identify topsoil storage with appropriate signage to prevent improper use.

Redistribution of Topsoil

To the greatest extent possible, soils would be reapplied as they were extracted. With permission of the BLM Authorized Officer topsoil may be moved from site while still viable to use on similar sites with similar soil characteristics.

Objective 5 - Re-establish the visual composition and characteristics to blend with the natural surroundings.

Newfield would reconstruct disturbed areas to the approximate original contour or to assure the site looks natural or blends with the surrounding terrain.

Objective 6 - Control the occurrences of noxious weeds and undesirable invasive species by utilizing principles of integrated weed management including prevention, mechanical, chemical, and biological control methods.

A pre disturbance noxious weed inventory shall be conducted on all surface disturbing projects to determine the presence of noxious weeds prior to beginning the project, and to determine whether treatment is needed prior to disturbance. If noxious weeds are found, a report including:

- A GPS location recorded in North American Datum 1983
- Species
- Canopy Cover or number of plants
- General infestation size (estimate of square feet or acres)

Information shall be provided to the BLM Weed Coordinator prior to the disturbance occurring, and also documented in the annual reclamation report.

Newfield would conduct weed management and control by using a process called Integrated Weed Management (IWM). Integrated Weed Management is a process at which all possible means of weed control are utilized. The processes within IWM include cultural, mechanical and chemical methods.

- Cultural methods include changing operations where possible to inhibit weed seed distribution through human means. Cultural changes could include quarantining certain "weedy" areas to only necessary traffic until treatments are completed, and washing vehicles more frequently.
- Mechanical methods may include mowing, tilling, or hand weeding small area of weed infestations.
- Chemical methods would include using commercial herbicides where required to keep weed infestations under control.

The use of grown mulch on reclaimable sites would effectively combat weeds during late spring/summer months.

Newfield would control any noxious and/or invasive weeds outbreak that is directly attributed to Newfield's activities.

Typical chemical treatments within the Green River District include bromacil, diuron, Dicamba, and Oust. The average application rate for these chemicals within the region is approximately 8.3 pounds per acre. An approved Pesticide Use Proposal (PUP) would be obtained for all planned herbicide applications. Herbicides would be applied by a certified applicator with a current Utah Pesticide Applicators License. A Biological Use Proposal is required for new bio-control agents in the Field Office area.

Objective 7 - Manage all waste materials

Newfield would segregate waste materials from the subsoil and topsoil.

All waste materials transported and disposed of off-site, would be placed in an authorized disposal facility in accordance with all local, State and Federal requirements.

Objective 8 – Conduct monitoring that is able to assess the attainment or failure of reclamation actions

Monitoring

Newfield would adhere to the Green River Guidelines 2011 monitoring guidelines as stated:

Monitoring methodology should be an approved BLM method designed to monitor basal vegetative cover. Monitoring criteria:

- Qualitative monitoring data would be collected after the 2nd growing season following reclamation actions. Quantitative data would be collected after the 3rd and 5th growing seasons, and the year that the applicant determines that reclamation meets the long term objective of 75% basal cover as compared to the reference site.
- In areas where the reference site data shows less than 5% basal cover, and is due to past land management practices, then the objective for the disturbed area that is being reclaimed would be 5% basal cover after the third growing season, and 8% after the fifth growing season.
- Any one species should not account for more than 30% of the total measured basal cover.
- All ROW's would include a monitoring transect per each NRCS ecological site that the ROW passes through that is greater than 0.75 miles.
- General view photographs of the reclaimed areas would be submitted with the quantitative data. Photographs would be taken at the same photo point each time, and as close to the same time of year as previous photos were taken to reduce differences in plant growth characteristics.

In cooperation with the Authorized Officer, an undisturbed reference site should be selected prior to monitoring. One reference site may be used for multiple reclamation sites as long the site potentials are similar. Reference site criteria:

- Reference sites shall be permanently marked, and the location recorded by Global Positioning System (GPS) North American Datum 1983.
- For ROW's a reference site shall be established in each unique NRCS Ecological Site that the ROW passes through.
- A photograph consisting of a general view of the marked reference site should be submitted with the Reference site data.

Newfield would document and report monitoring data and recommend revised reclamation strategies, if necessary. Newfield would submit an annual reclamation report to the Authorized Officer. The report would document compliance with all aspects of the reclamation objectives and standards.

Newfield would implement revised reclamation strategies as needed.

Newfield would repeat the process of monitoring, evaluating, documenting/reporting, and implementing, until reclamation goals are achieved, as determined by the Authorized Officer.

APPENDIX H

Water Quality Monitoring Plan

H.1 INTRODUCTION

This appendix provides a long-term water quality monitoring plan (monitoring plan) for the Newfield Greater Monument Butte Oil & Gas Development Project Environmental Impact Statement (EIS).

H.1.1 Monitoring Objectives

The overall objective of the monitoring plan is to document changes in water quality and quantity that could occur to Greater Monument Butte Project Area (MBPA) streams and water sources (e.g. Pariette Draw, the Green River, groundwater, and springs) over the life of the project (LOP). Monitoring data and reports would be shared with the Bureau of Land Management (BLM), Northern Ute Indian Tribe, U.S. Environmental Protection Agency (EPA), Utah Division of Oil Gas and Mining (UDOGM), Utah Division of Water Quality (UDWQ) Groundwater Protection Section, UDWQ Watershed Management Section, and the Operator.

To account for uncertainty associated with data available for the Greater Monument Butte EIS, this monitoring plan is designed to detect unanticipated impacts to water resources associated with the project. These unanticipated impacts may include:

- Contamination of surface water and/or groundwater by accidental spills of fuels, lubricants, fluid used for hydraulic fracturing, produced petroleum products, downhole impacts to groundwater or surface water, and leakage from reserve pits;
- Increased sedimentation and turbidity of surface waters;
- Increased concentrations of selenium, boron, and salinity;
- Decreased flows from springs near development areas due to groundwater use by drilling operations; and/or
- Changes in groundwater level in water supply wells near development area due to groundwater use by drilling operations.

It should be noted that, as disclosed in the Greater Monument Butte EIS, none of these impacts are expected to occur. Best Management Practices (BMPs) and Applicant-Committed Environmental Protection Measures (ACEPMs) that were incorporated into the analysis should mitigate the potential for impacts to water resources.

H.1.2 Quality Assurance and Sampling Analysis Planning

The first step in the implementation of this monitoring plan would be to develop a comprehensive quality assurance project plan (QAPP), including a comprehensive sampling analysis plan (SAP). Newfield would fund a qualified hydrologist (hereafter referred to as the hydrologist) to develop the QAPP and SAP. The QAPP would be developed using Environmental Protection Agency (EPA) guidance (EPA 2001) and would document the planning, implementation, and assessment procedures for the project, including sampling methods, laboratory procedures, data management and analysis, and reporting. The QAPP would ensure data quality meets the required formats and standards that are required to be incorporated into the current UDWQ database. This step is necessary to ensure that data collected provides reliable detection of impacts to water resources in or downstream of the MBPA. The QAPP would be prepared prior to any sampling collection, including baseline sampling, prior to commencement of the project. Implementation of this plan would provide information for the BLM to identify, evaluate, document, and monitor direct, indirect, and cumulative impacts to water resources. This plan would also provide the BLM with the tools necessary to determine appropriate response and mitigation measures in the unlikely event of impacts to water resources. The QAPP would be reviewed by the BLM, EPA, and the State of Utah before being approved by the BLM.

Prior to commencement of the Greater Monument Butte project, baseline data would be collected in accordance with the QAPP and SAP for all parameters listed in **Tables H-2**, **H-4**, and **H-6** for surface water, springs, and groundwater, respectively. Data would be collected from appropriate monitoring sites, as described in **Sections H.3.1**, **H.3.2**, and **H.3.3**.

H.2 SUMMARY OF EXISTING WATER QUALITY DATA FOR THE MBPA

The Greater Monument Butte EIS includes available existing water quality data for surface water and shallow groundwater within the MBPA. Surface water quality data have been collected for some parameters at three locations on Pariette Draw, and the U.S. Geological Survey (USGS) and the State of Utah provide regular monitoring of the Green River upstream from the MBPA. No data are available for ephemeral streams within the MBPA.

The surface water data collected consist of the following parameters:

- **Physical:** pH, alkalinity, temperature, specific conductance, dissolved oxygen (DO), DO saturation, turbidity, salinity, hardness, total dissolved solids [TDS], and total suspended solids [TSS]
- **Nutrients:** Inorganic nitrogen (nitrate plus nitrite), total phosphorus, orthophosphate, ammonia, Kjeldahl-nitrogen, total organic carbon, chemical oxygen demand, and potassium
- **Metals:** Aluminum, barium, cadmium, chromium, calcium, copper, iron, lead, manganese, magnesium, mercury, nickel, selenium, silver, sodium, and zinc
- **Other:** Bicarbonate, boron, arsenic, carbonate, chloride, hydroxide, and sulfate

Analyses of petroleum constituents (e.g., benzene, toluene, ethylbenzene, xylenes, methane, and hydrogen sulfide) have not been previously performed for either surface or groundwater; and therefore, there is currently no existing data to compare to future water quality data. Because there is existing oil and gas development in the area, any anomalies identified in future samples could not be directly related to the Greater Monument Butte EIS project without sufficient baseline samples.

Flow measurements were made at four USGS continuous flow gaging stations located on Pariette Draw in the late 1970s and early 1980s. These include USGS gages 09307200, 09307290, 09307295, and 09307300. More recently, flow was measured on several occasions in conjunction with water quality sampling at the two Utah Storage and Retrieval (STORET) monitoring stations located on Pariette Draw. USGS flow and water quality data is also available at USGS Gage 09272400 at Ouray, Utah.

As discussed in Section 3.6.2.3.2 of the EIS, Pariette Draw was assessed as impaired for agricultural activities (use designation 4) due to boron and total dissolved solids (TDS). Pariette Draw was also assessed as impaired for warm water species of game fish and other warm water aquatic life (use designation 3B) due to selenium (UDEQ 2010). Due to these exceedances, Pariette Draw is listed on Utah's 2010 303(d) list of impaired waters

Groundwater quality data have been collected for one shallow groundwater well (Newfield Well) within the MBPA, located in the Eight Mile Flat area (Section 29, Township 9 South, Range 18 East). The well is approximately 300 feet deep with a depth to groundwater of approximately 75 feet. The data collected are limited to general water quality parameters, including TDS, pH, major cations (calcium, magnesium, sodium), major anions (bicarbonate, sulfate, chloride), several trace metals (iron and manganese), and dissolved gasses (carbon dioxide, hydrogen sulfide).

If available and where pertinent, water quality data collected as part of the Gasco Long-Term Monitoring Plan would be used. Similarly, where pertinent water quality data collected as part of this plan would be shared with Gasco.

H.3 MONITORING SITE SELECTION, TYPES OF MONITORING AND PROTOCOLS, AND MONITORING FREQUENCY

H.3.1 Surface Water Monitoring

In addition to the existing data available for the MBPA, baseline surface water samples would be collected prior to commencement of the Greater Monument Butte project at the existing locations identified in Table H-1, and at potential new monitoring locations discussed in more detail below. The baseline samples would include at least one sample collected per location under baseflow conditions, as defined in the QAPP. All surface water samples collected during the first year of sampling (including those collected after commencement of the Greater Monument Butte project) would serve as the surface water quality baseline data against which potential impacts would be measured.

Long-term monitoring of surface water quality would be conducted at the four existing Utah STORET surface water quality locations listed in **Table H-1** and shown on **Figure H-1**. In addition, the BLM would work with the UDWQ to install and operate new monitoring stations. Potential locations for new monitoring stations are identified in **Table H-1** and shown on **Figure H-1.** These potential monitoring station locations were identified using a watershed approach whereby each station was conceptually placed downstream of tributary areas as well as downstream from concentrated development (both existing and conceptually proposed development). The goal for the placement of proposed monitoring stations is to allow the BLM to collect surface water monitoring data representative of the entire project area.

TABLE H-1. LONG-TERM SURFACE WATER QUALITY MONITORING STATIONS FOR THE GREATER MONUMENT BUTTE LONG-TERM WATER RESOURCES MONITORING PLAN

WATER BODY	STORET NUMBER / PROPOSED MONITORING STATION	STATION NAME
Existing Stations		
Pariette Draw	4933476	Below flood control (below Castle Peak Draw)
Pariette Draw	4933480	1/3 mile above flood control dam (P 1000)
Pariette Draw	4933440	1 mile above confluence with the Green River (P 2000)
Green River	4937020	Green River near Ouray
Proposed Stations		
1	Wells Draw	S23 T8S R16E

WATER BODY	STORET NUMBER / PROPOSED MONITORING STATION	STATION NAME
2	Castle Peak Draw	S5 T9S R17E
3	Lower Pariette Draw	S14 T9S R19E
4	Sheep Wash	T9S R19E
A	Unnamed	S24 T8S R15W
B	Castle Peak Draw	S4 T9S R17E
C	Big Wash	S1T9S R17E
D	Unnamed	½ mile upstream of confluence with Upper Pariette Draw

Insert Figure H-1

At each surface water monitoring site, field parameters would be measured, and a sample would be collected for analysis of the parameters listed in **Table H-2**. For all parameters, the detection limit for each individual analysis would be reported in a database.

TABLE H-2. PARAMETERS FOR LONG-TERM SURFACE WATER MONITORING

FIELD AND GENERAL WATER QUALITY PARAMETERS	TRACE METALS	OTHER INORGANIC CONSTITUENTS	ORGANIC CONSTITUENTS
Total alkalinity	Aluminum	Ammonia	Volatile organic compounds (VOCs)[1]
Temperature	Barium	Arsenic	Semi-volatile organic compounds[2]
Specific conductance	Cadmium	Bicarbonate	Radionuclides
pH	Calcium	Boron	Total petroleum hydrocarbons[3]
DO	Chromium	Carbonate	Inorganic nitrogen
DO saturation	Copper	Chloride	Total phosphorus
Turbidity	Iron	Hydroxide	Potassium
Dissolved hardness	Lead	Sulfate	Orthophosphate
TDS	Manganese	–	Kjeldahl-nitrogen
TSS	Magnesium	–	Total organic carbon
Flow	Mercury	–	Chemical oxygen demand
Aquatic habitat	Nickel	–	–
Geomorphology	Selenium	–	–
–	Silver	–	–
–	Sodium	–	–
–	Zinc	–	–

1 VOCs would be analyzed using EPA Method 8260 or a fully equivalent standard method. Benzene would be analyzed at a detection limit of 1 microgram per liter or lower.

2 Semi-volatile organic compounds would be analyzed using EPA Method 8270 or a fully equivalent standard method.

3 Total petroleum hydrocarbons would include, at a minimum, analysis for diesel-range organics and gas-range organics.

Samples would be collected on a quarterly basis (one each in the winter, spring, summer, and fall), and one storm sample per year would be collected at each STORET site and the Green River site downstream of MBPA over the LOP. Storm events could also potentially be monitored at the following locations: 1) the draw exiting the project area in the NE 1/4 of T8S:RI6E, 2) upstream of the downstream convergence from STORET monitoring site in T8S:R18E close to line with T9SR18E, 3) the draw just upstream of the Green River in SE 1/4 T9S:RI9E and 4) the SE 1/4 of T9S:RI8E before the convergence with Green River. Storm events would be defined in the QAPP in terms of precipitation and/or flow. Flows at each site would be directly measured at the time each sample is collected. Depending on the magnitude of flow, measurements would be taken using the most appropriate method. The frequency of storm event monitoring would be determined by the BLM in coordination with the UDWQ.

Sampling events from the Pariette Draw monitoring stations would be used to help determine if any further impact on the already impaired stream is occurring. If further degradation of the impaired stream is documented and determined to be the result of the Monument Butte project additional mitigation measures would be determined by the BLM and State of Utah, which could include enhanced erosion control and stormwater control measures for development upstream of Pariette Draw.

H.3.2 Spring Monitoring

In addition to the existing data available for the MBPA, at least two but preferably three baseline spring water samples would be collected prior to commencement of the Greater Monument Butte project. All spring water samples collected during the first year of sampling (including those collected after commencement of the Greater Monument Butte project) would serve as the spring water quality baseline data against which potential impacts would be measured.

As discussed in Section 3.6.3.2 of the EIS there are only four known springs within the MBPA (**Table H-3**). Long-term monitoring of water quality at selected springs would be conducted at the four springs listed in **Table H-3** and shown on **Figure H-1**. The springs selected are located within the MBPA and have water rights associated with stock watering.

TABLE H-3. LONG-TERM SPRING MONITORING LOCATIONS

SPRING NAME AND NUMBER	LOCATION	WATER RIGHTS NUMBER
Unnamed Spring	Section 21, Township 9 South, Range 17 East	47-1332
Odekirk Spring	Section 31, Township 8 South, Range 18 East	47-1581
Pleasant Valley Seep	Section 23, Township 8 South, Range 17 East	47-1602
Felter Spring	Section 21, Township 8 South, Range 17 East	47-1439

At each spring monitoring location, field parameters would be measured, flows would be measured, and a sample would be collected for analysis of the parameters listed in **Table H-4**. For all parameters, the detection limit for each individual analysis would be reported in a database. The inclusion of detection limits would allow for the accurate calculation of mean concentrations for parameters with large numbers of non-detect values. Samples would be collected on a quarterly basis (one each in the winter, spring, summer, and fall) at each spring over the LOP.

Flows at spring locations would be measured as near to the spring source as possible; measurement methods would be the same as those described under surface water. If flow is too low for these methods, alternative methods to measure or estimate flow may be considered. Similarly, if flows are too low to sample, photographic records of spring conditions would be captured.

TABLE H-4. PARAMETERS FOR LONG-TERM SPRING MONITORING

FIELD AND GENERAL WATER QUALITY PARAMETERS	TRACE METALS	OTHER INORGANIC CONSTITUENTS	ORGANIC CONSTITUENTS
Total Alkalinity	Aluminum	Ammonia	Volatile organic compounds (VOCs)[1]
Temperature	Barium	Arsenic	Semi-volatile organic compounds[2]
Specific Conductance	Cadmium	Bicarbonate	Radionuclides
pH	Calcium	Boron	Total petroleum hydrocarbons[3]
DO	Chromium	Carbonate	Inorganic nitrogen
DO saturation	Copper	Chloride	Total phosphorus
Dissolved Hardness	Iron	Hydroxide	Potassium
TDS	Lead	Sulfate	Orthophosphate
Flow	Manganese	–	Kjeldahl-nitrogen
TSS	Magnesium	–	Total organic carbon
Turbidity	Mercury	–	Chemical oxygen demand
–	Nickel	–	–
–	Selenium	–	–
–	Silver	–	–
–	Sodium	–	–
–	Zinc	–	–

1 VOCs would be analyzed using EPA Method 8260 or a fully equivalent standard method. Benzene would be analyzed at a detection limit of 1 microgram per liter or lower.

2 Semi-volatile organic compounds would be analyzed using EPA Method 8270 or a fully equivalent standard method.

3 Total petroleum hydrocarbons would include, at a minimum, analysis for diesel-range organics and gas-range organics.

H.3.3 Groundwater Monitoring

Baseline groundwater water samples would be collected at available and accessible[1] groundwater wells within the MBPS prior to commencement of the Greater Monument Butte project. Currently, there are five existing water wells within the project area. Assuming access is granted, all five of these wells would be sampled in advance of project initiation. All new water wells within the MBPA would also be sampled prior to project initiation or when the new well comes online (whichever comes first). Detailed monitoring protocols and final well selection would be identified in the QAPP and SAP prior to any drilling.

The purpose of the baseline monitoring network would be to 1) establish baseline groundwater quality for the major known aquifers in the area that could be impacted by drilling; 2) establish baseline groundwater quality for any freshwater aquifers and known drinking water sources in the area; and 3) establish monitoring points likely to be down-gradient of major project activities. All groundwater samples collected

1 Accessible wells include those for which the landowner and/or the owner/operator of the water well would grant permission to Newfield to sample.

during the first year of sampling (including those collected after commencement of the Greater Monument Butte project) would serve as the groundwater quality baseline data against which potential impacts would be measured. The following three types of monitoring wells would be considered for selection:

- *Drinking water or stock use wells.* The hydrologist would conduct a search of water rights within the area (via the Utah Division of Water Rights) for any water rights that are used for either drinking water or stock water. These could be wells, springs, or other diversion types. Following the database search, the hydrologist would conduct site visits of the potential monitoring points to verify that there is sufficient access and infrastructure to use the wells for semi-permanent monitoring. If monitoring points appear to be constructed in a manner that would allow for periodic sampling, the landowner would be contacted for permission to sample and for additional details regarding well construction (e.g., depth, screened interval, drilling logs).
- *Existing monitoring well networks.* The hydrologist would conduct a search of water rights in the area to identify any existing monitoring well networks. Following the database search, the hydrologist would contact owners and determine if these wells are accessible, evaluate the possibility of obtaining permission for sampling, and obtain additional construction details.
- *Other non-potable wells.* The hydrologist would identify additional non-potable wells in the area (likely through companies currently conducting oil and gas exploration) by directly contacting other oil and gas operators in the area.

Long-term monitoring of groundwater quality would be conducted at available and accessible water wells in the MBPA. **Table H-5** and **Figure H-1** depict known water wells within the MBPA. If access to a sufficient number of wells with good spatial distribution proves infeasible, shallow monitoring wells may be drilled in some areas to monitor potential freshwater resources. If a suitable number of existing wells cannot be identified in the QAPP for monitoring to adequately represent the groundwater in the project area, such as in drainages in Township 8-9 South Range 15-16 East, new monitoring wells would be installed. Given the programmatic nature of the project, it is not possible to know at this time which water wells would be hydraulically down-gradient from individual gas production wells. During the permitting process for individual project elements, additional site-specific monitoring may be required following selection of specific drilling, or in response to conditions encountered during drilling activities.

There are no delineated freshwater aquifers within the MBPA; however, identification of shallow freshwater aquifers could occur during site-specific drilling. Additional monitoring points would be added to the monitoring network on a site-specific basis if freshwater aquifers are discovered during the drilling process. If a freshwater aquifer is encountered during drilling, a search of the nearby area would be conducted to determine if any springs or wells access the same aquifer. If so, these monitoring points would be investigated for accessibility, and permission would be sought to add them to the monitoring network.

Water quality and quantity would also be measured at the proposed water collection station both prior to construction and drilling and within three months following operation. Results would be provided to the BLM, EPA, Bureau of Land Management (BLM), Utah Division of Oil Gas and Mining (UDOGM), the Utah Division of Water Quality (UDWQ) Groundwater Protection Section, and the UDWQ Watershed Management Section, and the Operator.

TABLE H-5. EXISTING LONG-TERM SHALLOW GROUNDWATER MONITORING LOCATIONS

NAME OF WATER RIGHT HOLDER	CADASTRAL LOCATION	WATER RIGHT NUMBER AND TYPE	WATER USES	DEPTH (FEET)	WATER QUALITY DATA AVAILABLE?
Newfield Production Company	T9S, R18E, Section 29	Well (47-1820)	Domestic, oil production	200–300	Yes
Inland Production Company	T8S, R17E, Section 21	Well (47-1805)	Unknown	4,990	No
Louis Clark Roberts	T8S, R17E, Section 21	Well (47-1346)	Unknown	Unknown	No
Clark and Arva Abegglen	T8S, R17E, Section 21	Well (47-1501)	Irrigation, Stock, Domestic	Unknown	No
USA Bureau of Land Management	T9S, R17E, Section 4	Well (47-1330)	Unknown	Unknown	No

At each groundwater monitoring location, field parameters would be measured, and a sample would be collected for analysis of the parameters listed in **Table H-6**. For all parameters, the detection limit for each individual analysis would be reported in the database. The inclusion of detection limits would allow for the accurate calculation of mean concentrations for parameters with large numbers of non-detect values; detection limits are required to be below applicable regulatory water quality standards or as specifically noted in **Table H-6**. Samples would be collected on a quarterly basis (one each in the winter, spring, summer, and fall) at each existing groundwater monitoring location, and any new groundwater monitoring location, over the LOP. Because baseline water quality data are limited, sample collection would include at least two rounds of baseline sampling prior to any drilling within the MBPA.

TABLE H-6. PARAMETERS FOR LONG-TERM SHALLOW GROUNDWATER MONITORING

FIELD AND GENERAL WATER QUALITY PARAMETERS	TRACE METALS	OTHER INORGANIC CONSTITUENTS	ORGANIC CONSTITUENTS
Total Alkalinity	Aluminum	Ammonia	Volatile organic compounds (VOCs)[1]
Temperature	Barium	Arsenic	Semi-volatile organic compounds[2]
Specific Conductance	Cadmium	Bicarbonate	Radionuclides
pH	Calcium	Boron	Total petroleum hydrocarbons[3]
DO	Chromium	Carbonate	Methane and isotopes of methane[4]
DO saturation	Copper	Chloride	Full gas chemistry (ethane, propane, butane, pentane, etc.)[4]

FIELD AND GENERAL WATER QUALITY PARAMETERS	TRACE METALS	OTHER INORGANIC CONSTITUENTS	ORGANIC CONSTITUENTS
Dissolved Hardness	Iron	Hydroxide	Hydrogen sulfide
TDS	Lead	Sulfate	Inorganic nitrogen
TSS	Manganese	–	Total phosphorus
Turbidity	Magnesium	–	Potassium
–	Mercury	–	Orthophosphate
–	Nickel	–	Kjeldahl-nitrogen
–	Selenium	–	Total organic carbon
–	Silver	–	–
–	Sodium	–	Chemical oxygen demand
–	Zinc	–	–

1 VOCs would be analyzed using EPA Method 8260 or a fully equivalent standard method. Benzene would be analyzed at a detection limit of 1 microgram per liter or lower.

2 Semi-volatile organic compounds would be analyzed using EPA Method 8270 or a fully equivalent standard method

3 Total petroleum hydrocarbons would include at a minimum analysis for diesel-range organics and gas-range organics.

4 Methane would be analyzed at a detection limit of 10 micrograms per liter or lower. If methane is detected above laboratory detection limits; isotopes of methane and full gas chemistry (e.g., methane, ethane, propane, butane, and pentane) would be analyzed.

Static groundwater levels would also be measured at the time of sample collection, prior to any pumping disturbance. Sampling techniques would be specified in the project-specific QAPP prior to data collection.

H.4 REPORTING OBLIGATIONS AND PLAN REVIEW

All water resources monitoring would be conducted under the supervision of a qualified hydrologist. Quarterly monitoring results would be entered into a database and summarized quarterly. Data and quarterly summaries would be delivered to the BLM Vernal Field Office, the UDWQ, and the UDOGM Roosevelt Office. In addition, the hydrologists who are responsible for monitoring activities will prepare an annual monitoring report. At a minimum, this report would contain a description of the monitoring results that identifies by location, observed trends in water quality, any identified potential impacts to water quality, flow conditions, changes in depth to groundwater, recommendations for changes in the long-term monitoring program, and recommendations for mitigation measures to reduce any impacts observed.

The BLM would review the monitoring plan every two years to determine 1) if the plan needs to be changed to adapt to data results; 2) the locations of active project construction; and 3) other project variables. However, these changes should meet the monitoring objectives described in **Section H.1** and defined in the project-specific QAPP. These changes could include relocation, addition, subtraction, or substitutions of monitoring locations or addition or subtraction of monitoring parameters, and an increase or decrease of monitoring frequency if evidence suggests that this is appropriate. All recommended changes, with an explanation for the requested change, would be submitted to the BLM and approved prior to implementation.

In addition to the annual reports, a cumulative assessment of the previous five years of monitoring results would be compiled every five years. A final report would also be completed at the conclusion of the project, which would summarize the entire monitoring program and include a final assessment of all sites monitored throughout the LOP. All monitoring reports would be submitted to the BLM, UDWQ, and UDOGM, and they would be made available to the public upon request.

H.4.1 Source Identification and Mitigation

Monitoring serves to identify the range, intensity, and effects of impacts directly or indirectly related to development. When and if a water resources concern is identified at an established monitoring point, BLM would work with Newfield (and potentially other operators in the area) to conduct an investigation that may include additional monitoring to identify the source of the problem. Water resources concerns associated with the proposed project would include any of the impacts described in **Section H.1**, including the presence of contaminants associated with oil and gas development, changes in water quality associated with surface disturbance, or changes in groundwater levels or stream flows. The QAPP would quantify monitoring "triggers" that would indicate the possible need for more intensive monitoring to identify the source (point or nonpoint) of the concern. At a minimum, these triggers would include drinking water quality standards, where applicable, and/or an established percentage above baseline data. If any of the parameters listed in **Tables H-2**, **H-4**, or **H-6** are found to be above established levels, the BLM, UDWQ, and UDOGM would be immediately notified, and source identification and mitigation measures would be considered by these agencies. The following are additional monitoring and/or mitigation measures that would be considered in the event of an identified impact:

- **Increased Sedimentation**
  - Review BMPs used for road, well pad, and pipeline construction to reduce sediment delivery to area streams.
  - Use additional sediment and erosion controls at well pads and along access roads.
  - Identify and increase treatment (paving, stabilizing, or surface treating) to critical portions of roads.
  - Relocate proposed well pads, roads, and/or pipelines to avoid erosion-prone areas.

- **Increased Concentrations of Inorganic Constituents, including Metals**
  - Review dust suppression program, including the types of chemical agents used, and modify if necessary.
  - Review BMPs used for road, well pad, and pipeline construction to reduce sediment delivery to area streams and increase implementation levels if necessary.
  - Use additional sediment and erosion controls at well pads and along access roads.
  - Identify and increase treatment (paving, stabilizing, or surface treating) to critical portions of roads.
  - Relocate proposed well pads, roads, and/or pipelines to avoid erosion-prone areas.
  - In cases of increased concentrations of selenium, boron, or TDS, collaborate with UDWQ to determine the source of the increase and whether oil and gas development has contributed to the increase. Implement appropriate BMPs to mitigate the identified source and/or pathway.

- **Contamination with Petroleum and other Organic Constituents**
  - Review the cementing program for well completion, including audits of cement bond records for wells near the impacted streams.
  - Conduct inspections of well pad facilities that may be leaking, including reserve pits, storage tanks, evaporation ponds, aboveground piping, and process units.

- Require complete remediation of any observed spills or leaks encountered during the well inspections.
- Review truck loading procedures for produced water and petroleum products.
- Require compensation to the well owner/water user and disclose the contamination of the impacted well, spring, or surface water to the EPA, and Utah Department of Environmental Quality.
- Identify and consider potential alternate sources of water (drill new well, haul water from offsite, etc.).

- **Reduction of Spring Flows**
  - Assess whether reduction in spring flow is seasonal fluctuation, due to drought, or the possible result of drilling activities.
  - Identify source area of spring using appropriate methods (e.g., tracer study), when feasible.
  - Review the cementing program for well completion, including review of cement bond logs for wells drilled near the impacted springs.
  - Collect all available historic records concerning pumping history and water levels in nearby water supply wells on spring flows. If feasible, implement continued measurements of pumping rates and water levels in water supply wells.
  - Require compensation be made to users of impacted springs.
  - Implement conservation or water re-use procedures to reduce withdrawals from water supply wells near, or hydrologically connected to impacted springs.
  - Identify and consider potential, alternate sources of water (drill new well, haul water from offsite, etc.).

- **Reduction of Water Levels in Wells**
  - Identify whether the reduced water levels are substantial and affect the availability of water (i.e., below pump intake).
  - Review the cementing program for well completion, including review of cement bond logs for wells drilled near the impacted water sources.
  - Evaluate the effects of water supply wells on existing water sources.
  - Require that compensation be made to users of impacted wells.
  - Implement conservation or water re-use procedures to reduce withdrawals from water supply wells near, or hydrologically connected to impacted wells.
  - Identify and consider potential alternate sources of water (drill new well, haul water from offsite, etc.).

H.5 REFERENCES

U.S. Environmental Protection Agency (EPA). 2001. EPA Requirements for Quality Assurance Project Plans. Available at: http://www.epa.gov/quality/qs-docs/r5-final.pdf. Accessed May 15, 2011.

APPENDIX I
2012 USFWS Draft Energy Development Management Guidelines for *Sclerocactus wetlandicus* and *Sclerocactus brevispinus* Core Conservation Areas

2012 USFWS

Draft Energy Development Management Guidelines for

***Sclerocactus wetlandicus* and *Sclerocactus brevispinus* Core Conservation Areas**

Introduction

Energy development across the Uinta Basin and throughout the ranges of *Sclerocactus wetlandicus* and *S. brevispinus* is occurring at a high level. The Vernal Bureau of Land Management (BLM) is preparing environmental impact statements (EISs) for several large energy field developments, which are scheduled for completion within the next year.

History of *Sclerocactus* and Energy Development in the Uinta Basin

The BLM included conservation measures for *Sclerocactus* species in the Vernal Field Office Record of Decision and Approved Resource Management Plan (hereafter "RMP," (BLM 2008) and the Service consulted on these conservation measures. These conservation measures are also currently followed by the Bureau of Indian Affairs (BIA). We currently consult on energy development projects with both the BLM and BIA that have potential to impact *Sclerocactus* species and include these conservation measures. Despite these efforts, impacts are still occurring to the species on a landscape level, the effects of which we lack the capability to analyze in consultations. These impacts include:

- **Maintenance activities.** In previous consultations, operators were not required to contact the BLM or Service if they had to conduct maintenance work in an area occupied by cacti. Once a right-of-way or APD is issued, the company is not required to contact the BLM if they will enter an area where cacti are likely or even known to occur. This can result in loss of cacti that was not considered in the original consultation. For example, in 2010, a cactus in an abandoned pipeline right-of-way was run over when maintenance crews went in to remove the pipeline (65411-2011-TA-0007 Anadarko NBU 188 cacti in pipeline ROW, file on record in the Service's online tracking and integrated logging system). This is a rare but not isolated incident.
- **New development within occupied habitat.** Although mitigation measures included in the RMP recommended that development avoid occupied habitat, development within

occupied habitat is not prohibited and still occurs. Examples include, but are not limited to, the following projects: 65411-2008-TA-0102 Anadarko Plant Monitoring Plan, 65411-2010-F-0149 Questar ML 104 Pipeline 24 Mile Extension, and 65411-2009-F-0129 Newfield's Ute Tribe Wells 9-35-4-1, 1-1-5-1, 10-6-5-2, 14-6-5-2, and 3-8-5-2.

- **Historical development within occupied habitat.** *Sclerocactus* species have been listed since 1979, but surveys and avoidance across the range of the species were not consistently required prior to 2006. Thus, many areas thought not to contain cacti were declared "non-habitat" for either *Sclerocactus* species and were developed. Some of these areas were later discovered to contain *Sclerocactus* individuals, but we have no way to track how many plants were lost from historical development.
- **Cumulative impacts across the range of the species.** Current biological information indicates that even a 300-foot buffer may not be sufficient to protect at least the pollinators of *Sclerocactus* species (Tepedino et al. 2010). Other dispersed impacts include the spread of invasive weeds, loss of connectivity between populations, fugitive dust, and barriers to dispersal.
- **Commitments in previous biological opinions to protect species not completed.** In order to avoid a jeopardy decision in the CastlePeak/Eightmile Flat EIS (include tails number here), the BLM agreed to monitor *Sclerocactus brevispinus*, complete surveys for this species, and develop a management plan for this species. To date, none of these commitments has been completed, although development continues across the range of *S. brevispinus*. Although the Pariette Wetlands Area of Critical Environmental Concern (ACEC) was developed, in part, to protect *Sclerocactus brevispinus*, the "no surface occupancy" stipulation does not apply to lands already leased in the ACEC, which is only 5 percent of the land contained within the ACEC. Thus, 95 percent of the Pariette Wetlands ACEC is open to development under current management.

Although all of the above examples are specific to the BLM, these impacts to *Sclerocactus* are similar across all lands where the species occur, regardless of landowner. For the purposes of this document, we will refer to "federal land management agencies" throughout, which includes the BIA and BLM. These agencies currently manage federal lands that contain *Sclerocactus* and are under obligation of the Endangered Species Act to protect listed plant species.

We concluded that all of the above project-related impacts, included in individual project consultations, are not likely to jeopardize the continued existence of *Sclerocactus* species. In reviewing the current state of energy development and *Sclerocactus* protection in the Uinta Basin, current conservation measures have not prevented destruction of plants and habitat, and are continuing to chip away at the integrity of these species on a landscape level. To date, we do not have an accurate way to measure cumulative impacts to *Sclerocactus* species because we lack total surface disturbance information. This lack of information makes it nearly impossible to tell at what point we have appreciably reduced our ability to recover either species. Thus far, management of these species has operated under an "avoid jeopardizing the species" paradigm, and we favor a more active approach to set aside areas so that we can work toward recovery of *Sclerocactus* species. Considering all of the above factors led us to develop the following "core conservation areas" to ensure that *Sclerocactus* species can be recovered, especially in light of upcoming energy development projects that continue to increase the level of development in *Sclerocactus* habitat and across both species' ranges.

<u>Purpose and Explanation of Core Conservation Areas</u>

We developed these management recommendations and core conservation areas to meet recovery objectives for *Sclerocactus brevispinus* and *S. wetlandicus*. The Recovery Plan for *Sclerocactus glaucus*, which included *S. brevispinus* and *S. wetlandicus* at the time, states:

> "Four … populations must be on lands with formal management designations which would provide long term, undisturbed habitat for *S. glaucus.*"

More recent recovery outlines for both *Sclerocactus brevispinus* and *S. wetlandicus* state:

> "Identify sites in urgent need of habitat protection, set protection priorities, and implement protective measures … establish formal land management designations to provide for long-term protection of important populations and habitat" (Service 2010a, 2010b).

To meet these recovery goals, we developed two levels of core conservation areas (Figure 1). Core areas were based on pollinator travel distance and were designed to provide habitat connectivity between populations and individuals (see Tepedino 2010). Level 1 polygons include the densest concentrations of cactus locations and the most restrictive management recommendations. Level 1 polygons were developed using a 400-meter buffer around plants to allow for pollinator travel. Level 2 polygons include less-dense cactus areas and less restrictive management recommendations, while still maintaining a minimum amount of undisturbed habitat to protect *Sclerocactus* species. Level 2 polygons were developed using a 1,000-meter buffer around plants. Both levels of conservation areas include connectivity between cactus locations to minimize habitat fragmentation. Preserving connectivity is also important because *Sclerocactus* species are out-crossing and require pollen from another plant's flower to produce viable seed (Tepedino et al. 2010). Thus, maintaining pollinator habitat and pollinator populations is important for survival and recovery *Sclerocactus* species. Detailed methods describing how these polygons were developed are provided in the "Methods" section below.

In this document, we address both *Sclerocactus brevispinus* and *S. wetlandicus* with the same management recommendations. We recognize that *S. brevispinus* has a more limited distribution compared to *S. wetlandicus* and thus may merit more stringent protective measures. For simplicity, we kept management recommendations the same between the two species. Both *Sclerocactus* species are known to introgress, and we lack clear geographic delineation between the two species. Additionally, threats to both species are similar across the landscape. For example, Level 1 polygons for *S. brevispinus* are approximately 6.8 percent disturbed and for *S. wetlandicus* are approximately 7.8 percent disturbed (Service). We acknowledge that separate management recommendations can be developed for the Upper and Lower Pariette Core Conservation Areas, where the bulk of *S. brevispinus* populations occur, and we will consider modifying these management recommendations if research becomes available to indicate this is appropriate. In the meantime, we recommend the same management strategies across the range of both *Sclerocactus* species. We also welcome alternative management recommendations if federal land management agencies with to provide these.

<u>Implications for Future Consultations</u>

If actions occur within these areas but follow the management recommendations below, then we will provide concurrence with a "may affect, not likely to adversely affect" determination made by the federal land management agency. Following the management recommendations included herein will also help us move toward recovery and delisting of

Sclerocactus species within the next ten to fifteen years. Three-hundred foot buffers will need to be followed outside of the core conservation areas, much as they have been followed to date. If these management recommendations are not followed, we will continue with the section 7 consultation process as we have in the past and will evaluate each project on an individual basis. However, we suspect that, with the level of development already existing within these core areas, that a jeopardy decision is more likely to happen in the future.

<u>General Management Recommendations</u>

The following management recommendations are presented from general recommendations that should be applied across all Core Conservation Areas, to Level 2 recommendations (specific to Level 2 Core Conservation Areas but should also be applied to Level 1 Core Conservation Areas unless more restrictive Level 1 recommendations apply), to Level 1 recommendations which are the most restrictive.

1. All conservation measures for *Sclerocactus* species that are included in Appendix L of the BLM Vernal Field Office Record of Decision and Approved Resource Management Plan, October, 2008 will be implemented.
2. A monitoring plan covering the entire range of each *Sclerocactus* species, including the core conservation areas, will be developed by the federal land management agencies in coordination with the Service within 1 year of finalization of these Energy Development Management Guidelines. Monitoring plots will be established across both *Sclerocactus* species' ranges, including the core conservation areas, within 1 year of completion of the monitoring plan. The purpose of the monitoring is to quantify threats to the species (for example, habitat fragmentation, fugitive dust, and invasive weeds), monitor population growth or decline, and collect demographic information for the species.
3. The Service will be contacted within 24 hours in the event of any emergency or unforeseen situation in which cacti or habitat within core conservation areas will be damaged or lost.

<u>Level 2 Core Conservation Areas (1,000 meter)</u>

1. Well density will not exceed 4 to 6 wells per section (typically, 160-acre surface spacing, including non-reclaimed plugged and abandoned well pads[1]). We assume that each well creates 5 acres of associated surface disturbance, and thus 4 to 6 wells per section equates to roughly 3 to 5 percent total surface disturbance. In areas where this threshold is already exceeded, any new surface disturbance[2] will be limited to existing disturbed areas. If previously disturbed areas are successfully reclaimed (see #3 below), then new surface disturbance may occur as long as total cumulative disturbance (including areas that have been reclaimed) does not exceed 25 percent of land surface area. Total cumulative disturbance is defined as areas that have been disturbed by the removal of the soil surface whether they have been reclaimed or not. Alternative drilling methods that allow access to existing oil and gas resources with minimal additional surface disturbance are encouraged. For example, directional drilling may allow for complete development of an oil or gas field while minimizing additional surface disturbance. We encourage this and other advanced technologies that may become available.
    a. For core conservation areas where 40-acre well surface spacing has already been developed, these areas will receive reclamation priority. If total surface disturbance in a core area already exceeds 5 percent disturbance, reclamation will need to occur to lower this amount of surface disturbance below the 5 percent threshold before additional surface disturbance can occur. Directional drilling and other energy-related activities can still occur on previously disturbed areas.
2. At any given time, total surface disturbance will not exceed 5% of the total area contained in each of the eight Level 2 polygons: Upper Pariette, Lower Pariette,

[1] The Utah Division of Oil, Gas, and Mining (UDOGM) counts any well that is plugged and abandoned as "plugged and abandoned," whether it has been reclaimed or not. The BLM considers a well plugged and abandoned only after it has been successfully reclaimed. We do not currently have an accurate geographic data layer that shows BLM plugged and abandoned wells; we currently have access only to UDOGM plugged and abandoned data. We will continue to use UDOGM plugged and abandoned data until or unless the BLM can provide documentation of plugged and abandoned well pads that have been successfully reclaimed.

[2] For the purposes of this document, total surface disturbance is defined as areas that have had the soil surface removed for construction for oil and gas activities and have not yet met the definition of successful reclamation by the federal land management agency.

Upper Green, Middle Green, Lower Green, Upper Nine Mile, Bonanza, and White River.

In setting this disturbance cap, we made several assumptions:

- We assume that a minimum level of disturbance is necessary for the survival and recovery of *Sclerocactus* species. There is no indication of a universal disturbance or fragmentation threshold that rare, endemic species can tolerate. Additionally, such research would need to be species-specific. Regardless, habitat for *S. brevispinus* and *S. wetlandicus* continues to be chipped away because of current land management practices, and we need time to obtain data showing how current management is impacting the species before so much habitat is gone that neither species can be recovered. Thus, we strongly recommend setting aside some areas for limited disturbance, which will allow time to monitor trends for the species and determine if current management practices are negatively impacting *Sclerocactus* species. In other recovery plans for plants, core conservation areas are established that exclude all surface disturbance within a core area (Service 2005, Service 2007). We did not take this approach for our Level 2 core conservation areas because most occurrences of either *Sclerocactus* species have experienced substantial development.
- We assume that in some areas of dense cactus occurrences, a minimum level of disturbance needed to recover the species has already been exceeded. In other draft recovery plans (Service 2011), recommendations in occupied habitat include no disturbance, with suitable habitat recommended to contain no more than 10 percent cumulative disturbance. Because we have little occupied habitat that remains undisturbed and suitable habitat for *Sclerocactus* species has been difficult to define, we set our disturbance cap between zero and 10 percent, at 5 percent. This will allow a low to moderate level of disturbance in areas with dense cactus populations while limiting development somewhat until we can obtain data showing impacts of development to *Sclerocactus* species.

- Finally, given a lack of information showing us how to best recover our listed species, we must err on the side of the species and show an abundance of caution in trying to protect and recover a species. We assume that some reduction in the trajectory of oil and gas development is necessary to the survival and recovery of *Sclerocactus brevispinus* and *S. wetlandicus*. This also means that recovery of *Sclerocactus* species requires a reduction in the amount of oil and gas revenue that operators and the federal land management agencies can obtain. Thus, we recognize there is a tradeoff between complete development of the oil and gas resources in the Uinta Basin and protection and recovery of *Sclerocactus* species. We believe establishing these conservation areas allows a moderate level of energy development within species habitat while allowing for species recovery.

We need the following research in order to make adaptive management decisions:

- Data showing the impact of current levels of development on *Sclerocactus* species. For example, if research shows that current levels of development are not negatively impacting *Sclerocactus* species, we will revise the disturbance cap accordingly. We expect preliminary research results within the next few years that will lend insight into how current levels of development are impacting *Sclerocactus* species.
- Monitoring data showing range-wide trends for *Sclerocactus* species. We are starting a rangewide monitoring program in 2012, funded initially by the Service with intended continued funding from the *Sclerocactus* mitigation fund. We expect preliminary results from this data within a few years. The BLM also has conducted monitoring data for several years and expect to provide results from this monitoring by the end of 2011. If monitoring data show a stable or increasing trend over time for *Sclerocactus*, then current levels of development can most likely be maintained. If monitoring data show decreasing trends for *Sclerocactus*, then current management will need to be adapted to be more protective.

- Research on how to identify and protect important *Sclerocactus* pollinator habitat. Some level of moderate development is likely to be compatible with the existence of *Sclerocactus* species (Tepedino et al. 2010), but we need to be able to identify and protect pollinator habitats so that gene flow can continue between *Sclerocactus* sub-populations. Some ground nesting bees can use disturbed areas, such as roadsides, for nesting habitat. Additionally, alternate food plants are needed to support *Sclerocactus* pollinator populations when *Sclerocactus* species are not flowering. We need research identifying how to protect native plant communities in order to maintain pollinator populations.

3. If the 5% disturbance cap is already met, no additional surface disturbance will occur until disturbed areas are successfully reclaimed by federal land management agency standards. For example, the Bonanza Level 2 core conservation area is currently at approximately 9% surface disturbance. Approximately half of the existing surface disturbance will need to be reclaimed before additional pads can be developed within this core conservation area.
4. Total existing surface disturbance will be quantified and mapped, as required by federal land management agencies annually. We expect that these data will be provided by energy operators, rather than collected by the BLM or BIA. Data will be provided electronically to the Service by the end of each calendar year. Spot checks will be conducted by federal land management agencies to ground-truth surface disturbance information.
5. A qualified third-party botanist will be on site prior to and during all construction activities to flag cacti or avoidance areas, train construction crews on how to avoid cacti, and ensure that construction and activities do not damage core conservation area habitat.
6. There are areas of existing disturbance (well pads and buried pipelines) in core conservation areas within 300 feet of cacti locations. For future maintenance activities in Level 2 areas with known cactus locations, operators will hire a qualified,

third-party botanist to flag cacti and otherwise assist crews in avoiding impacts to individual plants if the maintenance activity:

a. Is within 300 feet of known plant locations
b. Will involve off-road vehicle use (in pipeline right-of-ways) or other new surface disturbance,

If plants are flagged, the flags will be removed immediately after maintenance work has ceased If the maintenance activity will occur entirely on existing disturbance that does not have potential to contain cacti (for example, an existing dirt surface road or a well pad), then the company does not need an additional biological monitor.

<u>Level 1 Core Conservation Areas (400 meter)</u>

1. No new surface disturbance will occur in Level 1 core conservation areas. Surface disturbing activities will be restricted to areas of existing disturbance (for example, well pads, roads, and other rights-of-way).
2. Surface disturbing activities will occur outside of the flowering season, typically late April to mid-May, to avoid impacts related to fugitive dust and pollinator disturbance.
3. Plugged and abandoned wells (as per UDOGM definition) and non-maintained or abandoned rights-of-way within Level 1 core conservation areas will generally receive first consideration for reclamation activities. Federal land-management agencies in coordination with the Service will use their discretion to determine if other areas outside of Level 1 conservation areas are better suited or should be prioritized for reclamation activities.
4. Surface laid pipelines will follow existing rights-of-way. A qualified botanist will be on-site during pipeline work to train work crews to avoid cacti, temporarily flag cacti or avoidance areas, and ensure that core conservation habitat remains intact.
5. Federal land management agencies will complete comprehensive surveys throughout Level 1 core conservation areas. Survey results will provide an accurate population estimate and allow us to refine core conservation areas so we can more effectively protect the species. This will require evaluation of habitat components likely to support *Sclerocactus wetlandicus* and *S. brevispinus*

6. Total existing surface disturbance will be quantified and mapped by the land management agencies annually. We expect that these data will be provided by energy operators in the Uinta Basin, as these data were requested by the Vernal BLM in 2011. Data will be provided electronically to the Service by the end of each calendar year. Spot checks will be conducted by land management agencies to ground-truth surface disturbance information.

Review and Revision of Core Conservation Areas:

These conservation areas and management recommendations will be reviewed and updated as needed and as we receive new information. For example, currently there are no core areas connecting the center of the cactus distribution or connecting the Upper Nine Mile population with the main cactus populations. We expect that future surveys will find points connecting these locations, and conservation areas will be redrawn as necessary to include these data. Additionally, if we determine that some conservation areas are not important to *Sclerocactus wetlandicus*' existence and recovery, we will exclude these areas.

The above core conservation areas will be reviewed annually when we review new information to update the potential habitat polygon. This does not necessarily mean that the core areas will be updated annually. If, in our annual review, additional information is available to merit updating the core areas, we will do so. Additional information that may trigger an update include but is not limited to:

1. New data points between existing populations that connect populations that were previously thought to be disjunct.
2. Research indicating that current levels of management are not detrimental to the species

Currently, the Level 1 core conservation areas represent 7.5 percent and the Level 2 core conservation areas represent 23.9 percent of the *Sclerocactus* potential habitat polygon. We will limit future updates of core conservation area updates to no more than 10 percent of the potential habitat polygon for Level 1 and 25 percent of the *Sclerocactus* potential habitat polygon for Level 2.

We expect better predictive models of potential habitat within the next year. We will re-examine core conservation areas and the potential habitat polygon when this information is available, but we will maintain a 10 and 25 percent target as the maximum amount of area from the range of the species to be contained within the core conservation areas.

Land Management within Core Conservation Areas

The table below show the amount of core conservation areas by landowner.

Core Conservation Area	State Acres (percent)	Private	Tribal	BLM	Total
Level 1 (400 m)	2,307 (6%)	1,347 (4%)	13,460 (35%)	21,656 (56%)	38,770
Level 2 (1000 m)	11,111 (9%)	5,421 (4%)	36,593 (30%)	70,779 (57%)	123,904

Clearly, federally-managed lands provide the greatest opportunity to protect *Sclerocactus* species. Ute Tribe lands managed by the BIA are also important. The endangered species act does not apply to listed plants that occur on lands without a federal nexus. However, the state and private lands in the table above include some lands for which there is a federal nexus (for example, mineral rights), and account for a small portion of the core conservation areas (although we do not have data available to accurately quantify how much of this land has a federal nexus). Regardless, in the calculations and recommendations included in this document, we consider all disturbances within core conservation areas, regardless of landowner. Thus, if additional disturbance occurs on state or private lands, this may limit the additional disturbance that may occur on federal lands. Many of the oil and gas operators operating in the Uinta Basin conduct their development projects across fields that are a matrix of land owners. Applying the same standards across core conservation areas, regardless of landowner, should act as an incentive to operators to adhere to conservation recommendations across their field developments, which some operators currently do. Furthermore, impacts to *Sclerocactus* species do not change depending on who owns the land; *Sclerocactus* responses to impacts remain similar across the range of these species.

Other Threats to *Sclerocactus*

Other threats to *Sclerocactus* species include grazing, OHV use, illegal collection, invasive weeds, predation, and climate change. All of these threats can be exacerbated by oil and gas development. For example, removal of native vegetation for oil and gas well pads and roads reduces the amount of area that livestock can graze, thus increasing the intensity of grazing in undisturbed areas. Or increased road development in oil and gas fields increases the potential for OHV access and off-road vehicle use or access for the illegal collection of *Sclerocactus.*

While we recognize that these other uses can impact *Sclerocactus* species, we feel that development of management guidelines for these other uses (for example, grazing), is outside the scope of this document. We will develop additional guidelines to address other land management uses in later documents (recovery plan? Section 7 consultations on grazing?).

<u>Methods</u>

Kernal Density for All Levels of Core Conservation Areas

1. We performed a kernel density function on all cacti points in the Vernal BLM database as of February 3, 2011, as follows:
    a. Activate the Spatial Analyst toolbar in ArcMap 9.3.1, and select "Density" from the pulldown menu.
    b. Values entered for 400 m polygon
        i. Input data: "cactus_2_3_11"
        ii. Population field: "none"
        iii. Density type: kernel
        iv. Search radius: 400
        v. Area units: "Square miles"
        vi. Output cell size: 50

    Values entered for 1000 m polygon
        i. Input data: "cactus_2_3_11"
        ii. Population field: "none"
        iii. Density type: kernel
        iv. Search radius: 1000

v. Area units: “Square miles”

vi. Output cell size: 50

2. The distances used to develop the kernel density search radius were based on travel distances of common bee species that visit *Sclerocactus* plants. These bees are in the small and medium size range and travel approximately 400 meters to 1,000 meters between plants and nests (Tepedino 2010).
3. The produced continuous raster was reclassified (using the reclassify command within Spatial Analyst) into areas within the conservation areas and those outside using the cut points of 16.19 plants/square mile for the 400 m polygon and 2.59 plants/square mile for the 1000 m polygon. These two numbers represent the minimum density of plants (assuming a uniform distribution) that allows a pollinator to travel between plants using the above distances.
4. The reclassified raster was converted to a polygon using the raster to polygon command within Spatial Analyst.
5. All kernel density points were dissolved together into a single polygon.

Level 1 Core Conservation Areas (400 m) and percent disturbance calculations

1. After running the kernel density analysis, there were a few stand-alone Level 1 polygons that fell outside of the Level 2 polygons. These were deleted from the shapefile because they represent dense but disjunct sub-populations of cacti. We believe that landscape level conservation is best focused on centers of *Sclerocactus* populations—or “core” areas. Cacti outside of the core conservation areas still receive protection under the ESA.
2. The Level 1 polygons were divided into eight cactus areas following protocol for Level 2 polygons (see below). The shapefile was dissolved so that all the polygons in one cactus area were part of the same feature (a “multipart feature”).
3. Polygons received very little editing—the edges were left rough and many “donut holes” remained. Some very small donut holes (less than a few meters in diameter) were removed to eliminate holes in the polygon.
4. To estimate the amount of disturbance in each we used Xtools to calculate the land area in each 400 m core conservation area.

5. We sorted UTDOGM well data and selected only those wells that were not directional. This gives us an estimate of the number of wells and well pads within each cactus area.
6. We multiplied the estimated number of wells in each cactus area by 5 acres (the approximate amount of surface disturbance associated with each well pad, including roads and pipelines) to get an estimate of total disturbance within each cactus area. This number was divided by the total area for an estimate of total percent disturbance, as of March 2011 (Table 1).

Table 1. Percent disturbance within Level 1 core conservation polygons.

Cactus Area	Total Acres	# well pads	total acres disturbance	percent disturbed
Upper Pariette	8314	126	630	8%
Lower Pariette	6633	78	390	6%
Upper Green	3641	18	90	2%
Middle Green	6075	53	265	4%
Lower Green	3624	0	0	0%
Upper Nine Mile	523	0	0	0%
Bonanza	1705	44	220	13%
White River	8254	258	1290	16%

Level 2 Core Conservation Areas (1,000 m) and percent disturbance calculations

1. For kernel polygons that were disjunct from main populations, the polygon was edited by hand to connect these points to larger, nearby features. We hand-digitized the connections based on:
    a. SSURGO Cactus soil layer by cactus density/square mile: This shapefile was developed by categorizing SSURGO soil types based on cactus density: low (less than 16 cacti per square mile), moderate (16 to 260 cacti per square mile), or high (greater than 260 cacti per square mile) (Roe 2011, pers. comm.). We used

information from this shapefile to connect disjunct level 2 polygons if possible based on moderate or high soil categories.

b. STATSGO soil layer by cactus density/square mile: This shapefile was developed following the same protocol described above for the SSURGO data. We used this shapefile when SSURGO data, which contains higher resolution soil data, were not available. STATSGO soil categories based on cactus density are: low (less than 2.6 cacti per square mile), moderate (2.6 to 16 cacti per square mile), and high (more than 16 cacti per square mile).

c. NAIP imagery: Infrequently, we used NAIP imagery to connect polygons if we lacked soil data and the imagery showed that core areas were connected by similar land features

d. In absence of data from soils shapefiles or NAIP: Polygons were connected if their center points were separated by 1.5 km or less. We chose this number because it is the minimum recommended buffer distance between cacti for pollinators (Tepedino 2010). There are a few exceptions; see #2 below.

e. We did not typically connect features separated by rivers and streams. Many polygons in the current shapefile are connected across waterways, but this is an artifact of the kernel density function and these connects were not (and should not) be removed.

2. Additional edits specific to each cactus area are described below:

   a. Nine Mile:

      This polygon is the exception to the separation distance rule (see 1d, above). Some of the cactus points within this polygon are separated by more than 1.5 km (the minimum buffer distance recommended by Tepedino). However, very few surveys have been conducted in this area and, based on field experience, we believe there is additional occupied habitat between the available point data. We anticipate additional surveys in this area over the next few years will help us better delineate the polygon. Additional survey data should also determine if the Nine Mile population is connected with the Lower Green river population.

   b. White River:

There are disjunct populations to the south and west of the White River polygon that are not included in the core conservation polygon because the separation distance is greater than 1.5 km. We kept the easternmost White River polygon separated from the main portion of the White River polygon because we do not have information indicating that occupied habitat occurs between these two polygons.

c. Upper Green River:

The two northernmost cacti populations on the east side of the Green River (mostly within the refuge) are separated by more than 2 km and habitat in these areas is most likely not suitable for the cacti species (greasewood lowlands and cottonwood riparian). However, it is likely that suitable habitat skirts to the east along the alluvial benches on BLM and private land. Thus, we kept these core area polygons disjunct.

d. Middle Green River:

Many of the points in the Willow Creek area, east of the Middle Green River conservation area, were not included within the Middle Green River polygon due to separation distance. Additionally, the points directly to the north of the Middle Green River polygon are not connected—they are separated by more than 1.5 km and the Green River. We would eventually like to connect the Middle Green River polygon upwards with the Lower Pariette polygon, if soil data support this connection.

e. Lower Green River:

Cacti point locations within the southern portion of this polygon are disjunct in three places, all near the confluence of Nine Mile Creek, the Green River, and southward. All three of these gaps were maintained within the core conservation polygon. Cacti points in the first gap are separated by less than 1.5 km, Tepedino's minimum recommended buffer distance. Cacti in the second gap are separated by more than 2 km. However, these points are also separated by a soil type that is known in other areas to support high cactus densities. Finally, the southernmost group of cactus points is more than 2 km from the nearest points northward, but we lack surveys in this area and it is likely that there is continuous cactus habitat throughout this gap based on soil layers and our knowledge of the area.

f. Upper Pariette:

Point locations and Level 2 polygons were connected using methods described in #1 above: separation distance between points less than 1.5 km or soils and imagery data indicating that polygons should be connected.

g. Lower Pariette:

The easternmost points on the polygon were connected to the main polygon via the kernel density function dissolve. Additionally, the points are separated by approximately 1.5 km, which is just within Tepedino's recommended buffer distance.

h. Bonanza:

This polygon encompasses a disjunct and morphologically distinct population. The Level 2 polygon was developed via the kernel density function.

3. In a few cases, polygon edges were drawn to increase the buffer between known points and the edge of the polygon to ensure we maintained the minimum buffer distance.
4. We separated the core conservation areas into approximately equal areas within which to calculate disturbance caps based mostly on HUC level X watersheds. These groupings were based in part on watersheds.
5. We followed steps 4 through 6 above (for Level 1 polygons) to calculate the percent disturbed area for Level 2 polygons (Table 2), as of March 2011.

Table 2. Percent disturbance within Level 2 core conservation polygons.

Cactus_Area	total acres	# well pads	total acres disturbance	percent disturbed
Upper Pariette	23611	409	2045	9%
Lower Pariette	13092	134	670	5%
Upper Green	12864	64	320	2%
Middle Green	17848	152	760	4%
Lower Green	18101	3	15	0%
Upper Nine Mile	4661	9	45	1%
Bonanza	6515	119	595	9%
White River	27211	825	4125	15%

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Service 2010a

Service 2010b

Service 2011. GIS analysis.

Appendix A

Vincent Tepedino <Vince.Tepedino@usu.edu>

11/17/2010 12:10 PM

To
"Jessica_Brunson@blm.gov" <Jessica_Brunson@blm.gov>
cc

Subject
RE: the Greenleaf ms.

OK Jessi, we worked it all out for you:

The smallest bees are several of the Lasioglossum species and they would not be expected to travel very far: .05 (typical) - 0.1 (maximum) km; these bees are also fairly common but are probably less efficient pollinators than larger species.

The largest species are Bombus huntii (queens) and Anthophora affabilis: they would, of course, be capable of going quite a bit further: 3.7 (typical) - 8.5 (maximum) km. Neither species is very common.

The commonest bees are in the medium (and smaller) size range, i.e., Andrena prunorum, Agapostemon, Halictus rubicundis: you'd expect them to typically move about 0.4km with a max of about 1 km.

Were I you, I'd see if I could get away with a compromise distance of about 3 km with a minimum fall back of 1.5-2.0 km (roughly one mile).

Hope this helps.

Vince

From: Jessica_Brunson@blm.gov [Jessica_Brunson@blm.gov]
Sent: Tuesday, November 16, 2010 9:33 AM
To: Vincent Tepedino
Subject: Re: the Greenleaf ms.

Hi Vince,

Thanks for the paper ... it is a little confusing to me how we use the formula, but I can discuss it with you more after we get the measurements. Also, if time is an issue for the measurements, there are a couple of options for us. As I told you yesterday, we are trying to come up with some biologically justifiable buffers around cacti to develop conservation areas. For us to use pollinator travel distances, we would need, at a minimum:

1. Measurements of the largest and smallest specimen of each bee species (this would help us calculate minimum and maximum distances), or
2. IT measurements of the most common pollinator for each of the Sclerocactus species

Either of these options may save you some time and would still be useful to us. As always, you can call if you'd like to discuss in person (435-781-4448). Otherwise, I'll look for your next email.

Thanks for your help!
-Jessi

Vincent Tepedino
<Vince.Tepedino@u
su.edu>
11/15/2010 04:06
PM

To
"jessica.brunson@blm.gov"
<jessica.brunson@blm.gov>

cc

Subject
the Greenleaf ms.

Jessie, I'll try to let you know about the bee measurements in a couple of days.

Vince

APPENDIX J

USFWS Biological Opinion with Attachments and Supporting Documentation

1

Biological Opinion

I. Description of the Proposed Action

(W

IX. Conservation Recommendations

- While construction in the 100-year floodplain or wetlands is occurring, heavy equipment working on wet soils shall be placed on mats. Work should be conducted primarily while the ground is frozen or soils are dry.
- Silt fence shall be properly installed in 100-year floodplains and wetlands where project disturbance may erode into waters during a precipitation event.
- Where construction is completed, disturbed areas that are not needed for future maintenance shall be restored to the original grade and elevation immediately following construction.
- Weed control measures will be implemented throughout the action area.

X. Reinitiation – Closing Statement

This concludes formal consultation on the action outlined in your request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action was retained (or is authorized by law) and if: (1) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (2) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (3) a new species is listed or critical habitat designated that may be affected by the action.

We appreciated your efforts to work with us to protect threatened and endangered species. If the Project changes or it is later determined that the Project affects listed species differently than identified above; it may become necessary to reinitiate section 7 consultation. If we can be of further assistance, or if you have any questions, please feel free to contact Stephanie Graham at (801) 975-3330 ext. 155.

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Attachment 1

Final Conservation and Mitigation Strategy
For the Pariette Cactus and Uinta Basin Hookless Cactus,
Newfield Greater Monument Butte Project

5/26/2015

Introduction

Pariette cactus (*Sclerocactus brevispinus*) and Uinta Basin hookless cactus (*Sclerocactus wetlandicus*) (collectively referred to as *Sclerocactus*) are listed as threatened species under authority of the Endangered Species Act (ESA). Threats include mineral and energy development, illegal collection, recreational off-road vehicle use, and grazing [U.S. Fish and Wildlife Service (USFWS) 2010]. The primary goal of the endangered species program under the ESA is recovery of the species. In order to reach this goal, threats to the survival must be reduced and the species must be a secure, self-sustaining part of its ecosystem. While project proponents are not be required to recover a species through project-specific authorizations by Bureau of Land Management (BLM), under the Section 7 consultation process, the USFWS works with the applicant and action agency to develop conservation measures that benefit the species. A net benefit to *Sclerocactus* can be achieved through the protection of the cactus and suitable habitat throughout the species' range, reduction of threats through minimization of ground surface impacts, mitigation of project impacts, and restoration of previously disturbed lands.

Newfield is proposing to construct 5,750 wells on 1,245 new well pads, and accompanying roads and pipelines on its valid existing leases within the Greater Monument Butte Federal Oil and Gas Unit authorized by BLM. In the USFWS's designated core conservation areas (CCAs) for *Sclerocactus* and the *Sclerocactus* habitat polygon, Newfield is committed to avoiding direct impacts to *Sclerocactus* individuals when siting new well pads, well pad expansions, pipelines, access roads, and the installation of product flow lines that significantly reduce the impacts of truck traffic and associated dust impacts. Newfield commits to the *Sclerocactus* specific applicant committed conservation measures outlined in the USFWS Recommended Conservation Measures for *Sclerocactus*: Uinta Basin hookless cactus (*Sclerocactus wetlandicus*) and Pariette cactus (*Sclerocactus brevispinus*), 2014 (Appendix A). This includes a commitment to conduct surface disturbing activity outside of the *Sclerocactus* flowering period (March 15-August 30) for all work proposed within Level 1 CCAs and within 300 feet (ft) of *Sclerocactus* in Level 2 CCAs and the *Sclerocactus* Habitat Polygon. However, there are additional remaining potential impacts to *Sclerocactus* from Newfield's proposed action, including habitat disturbance and potential indirect impacts to the species from the remaining effects of dust.

This strategy has been devised to avoid, minimize, and mitigate for *Sclerocactus* throughout the Newfield Greater Monument Butte project area, while also being consistent with Newfield's valid existing lease rights, federal unit obligations, and proposed development, as well as BLM's legal authority and jurisdiction. The strategy is designed to allow the use of successful mitigation to offset Newfield's proposed new surface disturbance in Level 1 CCAs, surface disturbance above 5 percent or within 300 ft of *Sclerocactus* in Level 2 CCAs, and surface disturbance within 300 ft of *Sclerocactus* within the *Sclerocactus* Habitat Polygon.

Sclerocactus Habitat Mitigation

Tables 1 and 2 represent potential mitigation measures that may be completed in order to offset impacts associated with the Newfield Greater Monument Butte Project. Table 1 identifies mitigation options, and Table 2 explains the amount of mitigation needed per acre of new surface disturbance. Descriptive text follows the tables.

Table 1. Mitigation options to offset impacts to *Sclerocactus* habitat.

Requested Disturbance	Conservation Easement/NSO	Habitat Restoration, *Sclerocactus* Survival, Recruitment	Reduction in Truck Traffic	Mitigation Fund
CCA 1: 8 New Well Pads	✓	✓		
CCA 1: Well Pad Expansion	✓	✓	✓	✓
CCA 2: Current disturbance >5% and < 25%	✓	✓	✓	✓
CCA 2: Current disturbance < 5% and *Sclerocactus* within 300 ft	✓	✓	✓	✓
Sclerocactus Habitat Polygon: Disturbance within 300 ft of *Sclerocactus*	✓	✓	✓	✓

Table 2. Mitigation Ratios (mitigated acres:disturbance acres)

Disturbance Location	Disturbance Type	Mitigation Method								
		Conservation Easement/NSO		Restoration of Entire Facilities[1] (full well pads, roads, and pipelines)			Restoration Facility Edges[1]	Truck Traffic Reduction		Mitigation Fund (Appendix B)
		High Cactus Densities (A.1)	Moderate Cactus Densities (A.2)	Habitat Restoration	+Cactus Survival	+Cactus Recruitment		CCA 1	CCA 2	
CCA 1	8 new well pads	3:1	—	5:1	3:1	2:1	—	—	—	—
	Well pad expansion	3:1	—	5:1	3:1	2:1	—	20:1	—	$7,510/acre
Occupied habitat in CCA 2 or *Sclerocactus* Habitat Polygon[2]	All	1:1	2:1	4:1	3:1	2:1	4:1	S:1	10:1	$6,260/acre (CCA2) or $2,550/acre (Habitat Polygon)
Unoccupied habitat where CCA 2 >5% Disturbance[2,3]	All	1:1	2:1	1:1	1:2	1:3	4:1	S:1	10:1	$6,260/acre

[1] Restoration must occur in equal or greater quality habitat compared to the location of the new disturbance; e.g., restoration as mitigation for impacts to CCA2 must occur in CCA2 or CCA1 polygons.
[2] Occupied is defined as habitat < 300 ft from *Sclerocactus* individuals. Unoccupied is defined as habitat > 300 ft from *Sclerocactus* individuals.
[3] Mitigation is not required in unoccupied habitat where CCA2 <5% disturbance, or in unoccupied habitats of the *Sclerocactus* Habitat Polygon.

A. Establishment of Conservation Easements or Voluntary No Surface Occupancy in Occupied Habitat

Conservation easements or voluntary No Surface Occupancy (NSO) areas can be used to offset impacts in:

- Level 1 CCAs from 8 new well pads not to exceed 20 acres, or well pad expansion not to exceed limits analyzed in the Environmental Impact Statement (EIS),
- Level 2 CCAs that have current cumulative disturbance between 5 and 25 percent,
- Level 2 CCAs when disturbance is < 5 percent and within 300 ft of *Sclerocactus* *Sclerocactus* Habitat Polygon when disturbance is within 300 ft of *Sclerocactus*

The following *Sclerocactus* density criteria must be met for new conservation easements or NSO areas, unless otherwise approved by the USFWS:

<u>*A.1. Level 1 CCAs:*</u>

To offset new disturbance impacts in Level 1 CCAs, conservation easement or NSO areas must be occupied by *Sclerocactus* at a rate of at least 25 *Sclerocactus* per 40 acres, unless otherwise approved by the Service. *Sclerocactus* density rates would be determined by a USFWS qualified botanist;

<u>*A.2. Level 2 CCAs* and *Habitat Polygon:*</u>

To offset new disturbance impacts in Level 2 CCAs (above 5 percent per Level 2 CCA unit (occupied or unoccupied); Level 2 CCAs < 5 percent and within 300 ft of *Sclerocactus*; or the *Sclerocactus* Habitat Polygon, the establishment of conservation easements or NSO must be occupied by *Sclerocactus* at a rate of at least 15 *Sclerocactus* per 40 acres, unless otherwise approved by the USFWS.

In addition, new conservation easements or NSOs must meet the following criteria:

1. Parcel quality and size:
    a. At least 50 percent of the parcel is suitable habitat for *Sclerocactus*;
    b. The parcel is within the current range of *Sclerocactus*;
    c. The parcel has less than 5 percent existing surface disturbance;
    d. The parcel is a minimum of 40 acres;
    e. The surface of the conservation easement or NSO area is closed to future surface disturbing activities. Surface disturbing activities include but are not limited to new blading and leveling on ground surface, plowing, disking, harrowing, and any other activities that negatively affect habitat conditions or population stability; and
2. The conservation easement or NSO must be finalized and recorded prior to new disturbance.

3. Should the proposed easement or NSO parcel meet the criteria defined above, a proposal will be prepared by Newfield and submitted to the USFWS. Upon receipt, the USFWS will have 60 days to review and approve the conservation easement or NSO area.
4. The conservation easement or NSO shall be recorded with the property in perpetuity, or identified in the BLM land use plan as an NSO for the conservation and recovery of the *Sclerocactus*. The use of conservation easements or NSOs for mitigation will need to be approved by the USFWS on a site-specific basis. For BLM NSOs, USFWS approval will be in part dependent on the ability of BLM to: 1) reach an agreement for NSOs with lease holders, 2) ensure the long-term protection of the mitigation area by showing the intent to maintain the NSO designation in future land use plans, and 3) agree to discuss any future NSO changes and resultant additional conservation measures with USFWS.
5. The USFWS will be allowed access to the conservation easement to monitor the *Sclerocactus* and its habitat.
6. The purpose of the conservation easement or NSO area is to: (1) preserve the property in its existing, comparable, or better condition as suitable habitat for *Sclerocactus*; (2) preserve and protect the conservation values of the property; and (3) prevent any use of the property that will impair or interfere with *Sclerocactus*, its habitat, or other conservation values of the property.
7. Conservation Easement/NSO Monitoring and Management: Newfield will conduct a baseline assessment and mapping of the *Sclerocactus* population and assessment of habitat quality on conservation easement and NSO lands. Funding for future monitoring and management of NSOs on BLM land will be determined through coordination between Newfield and BLM.

   In the event that Newfield purchases private property and places a conservation easement on that property for the protection of *Sclerocactus* and/or its habitat, any future monitoring and management shall be contracted for and funded with Newfield's contributions to the *Sclerocactus* Mitigation Fund for this Greater Monument Butte Project.

   In the event that Newfield purchases a conservation easement through a third party private property owner for the protection of *Sclerocactus* and/or its habitat, then Newfield, USFWS, and the private property owner shall determine whether additional funds or other financial assurances to cover the costs of monitoring and any maintenance actions are deemed necessary. In the event such assurances are needed, then Newfield, USFWS, and the private property owner shall determine what mechanism will be most suitable at that time. Financial assurance for easements could be a one-time payment made by Newfield to an endowment which then would then bear interest to cover the monitoring and management costs. Financial assurances may also be similar one-time payments in the form of performance bonds, escrow accounts, insurance, collateral assignment of a certificate of deposit, certified or cashier's check, letter of deposit, or other approved instrument. Such assurances may be phased-out or reduced once it has been demonstrated that the easement is of low risk.

Conservation Easement or Voluntary NSO Exchange Ratios:

a. A 3:1 ratio (3 acres of conservation easement or NSO per 1 acre of new disturbance) will be implemented for Level 1 CCA disturbance if a conservation easement or NSO parcel is acquired according to the criteria as listed above (section A.1). No more than 20 acres of new well pads (associated with Newfield's proposed 8 new well pads) will be permitted in Level 1 CCAs. Disturbance acres for well pad expansions will not exceed the limit analyzed in the EIS.

b. A 1:1 ratio (1 acre of conservation easement or NSO per 1 acre of new disturbance) will be implemented for disturbance in Level 2 CCA and the *Sclerocactus* Habitat Polygon, if a conservation easement or NSO parcel is acquired according to the criteria as listed above (section A.1). All disturbances must be within the analyzed limit addressed in the EIS. This ratio will be used to offset impacts in Level 2 CCAs where new disturbance is within 300 ft of *Sclerocactus* or above the 5 percent disturbance threshold. This ratio will also be used to offset impacts where disturbance is within 300' of *Sclerocactus* within the *Sclerocactus* Habitat Polygon.

c. A 2:1 ratio (2 acres of conservation easement or NSO per 1 acre of new disturbance) will be implemented for disturbance in Level 2 CCA and *Sclerocactus* Habitat Polygon if a conservation easement or NSO parcel is acquired according to the criteria as listed above (section A.2). All disturbances must be within the analyzed limit addressed in the EIS. This ratio will be used to offset impacts in Level 2 CCAs where new disturbance is within 300 ft of *Sclerocactus* or above 5 percent disturbance threshold within Level 2 CCAs. This ratio will also be used to offset impacts where disturbance is within 300 ft of *Sclerocactus* within the *Sclerocactus* Habitat Polygon.

B. Sclerocactus Habitat Restoration, Sclerocactus Survival, and Sclerocactus Recruitment

There are opportunities in CCAs to reduce the existing surface disturbance of old well pads, roads, and cross-country pipeline rights-of-way, thereby restoring *Sclerocactus* habitat conditions and reducing fragmentation.

The applicant will use USFWS Mitigation Guidelines (USFWS 2014; Appendix B) and subsequent versions (as current information on arid lands restoration and *Sclerocactus* recovery evolves) to restore disturbed areas. Restoration includes additional measures beyond those used by the BLM in their reclamation guidelines. Topsoil development in arid lands is an extremely slow process. Once topsoil is removed, amendments may be necessary to provide the appropriate organic and inorganic soil constituents needed to support the biological community (Eldridge et al. 2012). The applicant will use the BLM Green River District Reclamation Guidelines and subsequent versions to reclaim disturbed areas. BLM reclamation guidelines require recontouring sites and reseeding them with native species. All areas will be reclaimed and restored and the applicant cannot re-disturb the restoration sites unless additional compensation (taking into account the prior loss of *Sclerocactus* habitats) fully offsets the loss.

Successful habitat restoration, survival, and recruitment (see Table 2) can be used to offset impacts in:

- Level 1 CCAs for new surface disturbance from the 8 new well pads.
- Level 1 CCAs for new surface disturbance from well pad expansion.
- Level 2 CCAs where cumulative disturbance level is between 5 and 25 percent for new surface disturbance.
  Level 2 CCAs that are below 5 percent cumulative disturbance for new surface disturbance that is within 300 ft of *Sclerocactus*.
- *Sclerocactus* Habitat Polygon for new surface disturbance where new disturbance is within 300 ft of *Sclerocactus*.

Restoration Standard

Restoration of Habitat shall be deemed sufficient if it meets the following criteria:

1. Reclamation meets the BLMs Green River District Reclamation Guidelines;
2. Restoration meets the 2014 Restoration Mitigation Guidelines (Appendix B); and
3. *Sclerocactus* are outplanted into the habitat via seed or starts from a Service approved authorized source and by a USFWS approved authorized individual that has been hired by Newfield.
4. If *Sclerocactus* do not survive within the first 5 years post outplanting, Newfield will consult with USFWS and outplant *Sclerocactus* a second time in order to achieve the Survival Standard. Only one additional outplanting is required (if the initial planting is not successful) after the initial *Sclerocactus* outplanting. After the initial outplanting, no *Sclercactus* monitoring is required past 5 years, regardless if a second outplanting is conducted.

Survival Standard

Survival of *Sclerocactus* shall be deemed sufficient if it meets the following criteria:

1. Within Level 1 CCAs an average of 8 or more *Sclerocactus* per acre are documented in the restored area after 5 years of monitoring, as verified by a botanist acceptable to the Service.
2. Within Level 2 CCAs an average of 4 or more *Sclerocactus* per acre rate are documented in the restored area after 5 years of monitoring, as verified by a botanist acceptable to the USFWS.

Recruitment Standard

Recruitment of *Sclerocactus* shall be deemed sufficient if it meets the following criteria:

New seedlings germinate within *Sclerocactus* habitat and survive to the juvenile life stage (approximately 2.5-4 cm).

Documentation and Monitoring

1. Documentation and Monitoring reports for restoration of habitat that will be sent to the USFWS on an annual basis shall include:

a. A report detailing number *Sclerocactus* individuals outplanted on reclaimed and restored habitat each year, the source of the propagated *Sclerocactus*, restoration company qualifications, GIS location of the outplanted *Sclerocactus*, and all methods used in the propagation and outplanting.
b. Third Year after Outplanting – report detailing the survival rate of the *Sclerocactus*, health (may be measured by size, color, or damage), recruitment, and reproduction, including photo documentation and field notes.
c. Fifth Year after Outplanting – report detailing the survival rate of the *Sclerocactus*, health (may be measured by size, color, or damage), recruitment, and reproduction, including photo documentation and field notes.

Restoration, Sclerocactus Survival, and Sclerocactus Recruitment Ratios

Table 2 lists ratios associated with restoration, survival, and recruitment.

Bond

If Newfield would like to start oil and gas development work before achieving successful habitat restoration, they will implement restoration and they will contribute to a bond. The bond price will be based upon the cost of restoration work plus an additional 25 percent to cover inflation and future increases in restoration costs. The total bond price will be $9,388 ($7,510 plus 25 percent) per acre of new disturbance within Level 1 CCA. The total bond price will be $7,825 ($6,260 plus 25 percent) per acre of new surface disturbance within: (1) Level 2 CCAs above 5 percent disturbance, but below 25 percent disturbance; or (2) Level 2 CCAs < 5 percent disturbance and within 300 ft of *Sclerocactus*. The total bond price will be $3,188 ($2,550 plus 25 percent) per acre of new surface disturbance within 300 ft of *Sclerocactus* in the *Sclerocactus* Habitat Polygon.

If the applicant does not choose to secure a bond, they will be responsible for successful habitat restoration (*Sclerocactus* propagation, outplanting, survival, and recruitment after 5 years of monitoring) prior to new surface disturbance: for Level 1 CCA, above 5 percent cumulative disturbance within Level 2 CCAs, < 5 percent and within 300 ft of *Sclerocactus* in Level 2 CCAs, and within 300 ft of *Sclerocactus* in the *Sclerocactus* Habitat Polygon.

Bond Release

The bond will be released after:

- Newfield has implemented complete restoration actions that meet the Restoration Standard (above).

C. Reduction of Dust Impacts

Reduction of dust impacts can be used to offset impacts in:

- Level 1 CCAs for well pad expansions
- Level 2 CCAs and the *Sclerocactus* Habitat Polygon.

Removal of oil and gas production facilities and equipment and replacement with pipeline conveyance systems will result in significant truck traffic reduction, which in turn reduces dust and related indirect impacts on listed plant species. For example, according to Newfield production data, approximately 340 tanker trucks travel to existing facilities in Level 1 CCAs each month. This volume is projected to increase between 500 to 700 tanker trucks per month between 2015 and 2018, and during maximum production, truck traffic could increase to over 3,000 tanker trucks per month. If produced oil and gas can be conveyed with flow lines and offsite tank batteries, all tanker truck traffic to producing well pads will be eliminated. Traffic will then be limited to operational, safety, and environmental compliance inspections which are conducted every other day by pick-up truck, as well as periodic work-overs and their associated traffic. By installing flow lines and offsite tank batteries, it is estimated that total traffic will be reduced by 95 percent from current volumes, and this percentage will increase over time.

According to Newfield, a total of 131.2 acres of roads in Level 1 CCAs and 298.6 acres of roads in Level 2 CCAs will be affected by this 95 percent reduction of tanker truck traffic if the flow line installation occurs. Road acreage is calculated by the acres of road width disturbance. The following mitigation ratios provide an exchange of dust abatement efforts for corresponding well pad expansions in Level 1 CCAs and new disturbance less than 5 percent in Level 2 CCAs.

1. Reduction of Truck Traffic and Dust Ratio
    a. For every 20 acres of roads that have reduced truck traffic by 95 percent within Level 1 CCAs, a well pad can be expanded by 1 acre within Level 1 CCAs.
    b. For every 5 acres of roads that have reduced truck traffic by 95 percent within Level 1 CCAs, Newfield could disturb 1 additional acre within Level 2 CCAs or the *Sclerocactus* Habitat Polygon.
    c. For every 10 acres of roads that have 95 percent reduced truck traffic within Level 2 CCAs, Newfield could disturb 1 acre of terrain within Level 2 CCAs or the *Sclerocactus* Habitat Polygon.

D. *Sclerocactus* Mitigation Fund

Sclerocactus Mitigation Fund and guidelines for restoration are included in Appendix B.

Literature Cited

Eldridge, J.D., E. F. Redente, and M. Paschke. 2012. The Use of Seedbed Modifications and Wood Chips to Accelerate Restoration of Well Pad Sites in Western Colorado, U.S.A. Restoration Ecology 4:524-531.

USFWS. 2010. Recovery Outline for the Sclerocactus *wetlandicus*. Utah Ecological Services Field Office, Salt Lake City, Utah.

USFWS. 2014. 2014 Ecological restoration mitigation calculation guidelines for impacts to Sclerocactus *wetlandicus* and Sclerocactus *brevispinus* habitat. Utah Ecological Services Field Office, Salt Lake City, Utah.

Appendix A

U.S. Fish and Wildlife Service Recommended Conservation Measures for *Sclerocactus*: Uinta Basin hookless cactus (*Sclerocactus wetlandicus*) Pariette cactus (*Sclerocactus brevispinus*) March 11, 2014

Conservation measures are actions that the action agency and applicant agree to implement to further species recovery. The beneficial effects of conservation measures are taken into consideration for determining the overall project impacts to species. The following list of conservation measures for Uinta Basin hookless cactus (*Sclerocactus wetlandicus*) and/or Pariette cactus (*Sclerocactus brevispinus*) (collectively referred to as *Sclerocactus*) will help minimize the impacts of a proposed action to these threatened species.

SCLEROCACTUS SURVEYS

- Pre-project habitat assessments will be completed across 100 percent of the project disturbance area within potential habitat prior to any ground disturbing activities to determine if suitable *Sclerocactus* habitat is present.

- Pre-construction *Sclerocactus* surveys will occur following the pre-project habitat assessments that identified any suitable habitat within the project area. These pre-construction surveys must follow U.S. Fish and Wildlife Service (USFWS) Utah Field Office Guidelines for Conducting and Reporting Botanical Inventories and Monitoring of Federally Listed, Proposed, and Candidate Plants. Surveys will be conducted in suitable habitat prior to initiation of project activities, at a time when the plant can be detected, and during appropriate flowering periods:

  - *Sclerocactus brevispinus* surveys must be conducted between March 15th and June 30th, unless an extension is provided in writing by the USFWS
  - *Sclerocactus wetlandicus* surveys can be done any time of the year, provided there is no snow cover.

- *Sclerocactus* surveys will be conducted by a qualified botanist. Qualifications are defined in the USFWS Utah Field Office Guidelines for Conducting and Reporting Botanical Inventories and Monitoring of Federally Listed, Proposed and Candidate Plants, http://www.fws.gov/utahfieldoffice/SurveyorInfo.html. Qualified botanists must also attend the USFWS Uinta Basin Rare Plant Workshop, http://www.fws.gov/utahfieldoffice/UBRarePlants.html.

- Surveys will be valid for one year from the survey date for *Sclerocactus brevispinus* and *Sclerocactus wetlandicus*.

- *Sclerocactus* spot check surveys will be conducted on an annual basis by a qualified botanist, and reviewed by the Bureau of Land Management (BLM) and our office for all planned disturbance areas if the project has not been completed within the year following pre-construction plant surveys. Review of spot checks may result in additional pre-construction plant surveys as directed the BLM and our office. If the proposed action has not occurred within four years of the original survey, additional coordination with the BLM and our office must occur and a new clearance survey may be necessary prior to ground disturbing activities.

- *Sclerocactus* surveys for access roads, buried pipelines, well pads, and other facilities requiring removal of vegetation (e.g., compressor stations) will include the project area and/or right-of-way (ROW), and 300 feet (ft) from the edges of the project disturbance and/or ROW.

- *Sclerocactus* surveys for surface pipelines placed within an existing road ROW, and within 10 ft from the edge of the disturbed surface of the road, will include the ROW and 50 ft from the edge of the ROW on the pipeline side of the road.

- *Sclerocactus* surveys for cross-country surface pipelines (pipelines over 10 ft from a road), where the pipeline will be laid by hand with minimal disturbance and no vehicle use will include the ROW and 50 ft from the edges of both sides of the ROW.

- Surveys for all other cross-country surface pipelines (vehicles or equipment used, not laid out by hand) will include the ROW and 300 ft from the edges of both sides of the ROW.

- *Sclerocactus* surveys will not be necessary when pipelines are buried in existing roads.

PROJECTS PROPOSED WITHIN *SCLEROCACTUS* HABITAT

General Measures

- Ground disturbing activities in Level 1 CCAs and within 300 ft of individual *Sclerocactus* plants and/or populations must occur outside of the flowering period, April 1 - May 30.

- Access roads, buried pipelines, well pads, and other facilities requiring removal of vegetation (e.g., compressor stations) will be located a minimum distance of 300 ft from individual *Sclerocactus* plants and/or populations where feasible (and in accordance with Level 1 and 2 CCA conservation recommendations, as outlined below).

- Surface pipelines will be located at a minimum of 50 feet from individual *Sclerocactus* plants and/or populations where feasible (and in accordance with Level 1 and 2 CCA conservation recommendations, as outlined below).

- New surface pipelines located closer than 50 feet to known *Sclerocactus* individuals will be secured in place to prevent pipeline movement (and in accordance with Level 1 and 2 CCA conservation recommendations, as outlined below).

- Only water and methods approved by the BLM (no chemicals, reclaimed production water or oil field brine) will be used for dust abatement measures within *Sclerocactus* habitat.

- Dust abatement will be employed in suitable *Sclerocactus* habitat over the life of the project during the time of the year when *Sclerocactus* species are most vulnerable to dust-related impacts (March through August).

- Noxious weeds within *Sclerocactus* habitat may be controlled with herbicides, in accordance with the BLM Herbicide PEIS (http://www.blm.gov/wo/st/en/prog/more/veg_eis.html). Guidelines and the BLM's Standard Operating Procedures for Threatened and Endangered Plant Species (Table 1).

- Application for a Pesticide Use Permit will include provisions for mechanical removal, as opposed to chemical removal, for Utah Class A, B, and C noxious weeds within 50 feet of individual/populations of *Sclerocactus*.

- Erosion control measures (e.g., silt fencing) will be implemented to minimize sedimentation to *Sclerocactus* plants and populations located down slope of proposed surface disturbance activities, and should only be implemented within the area proposed for disturbance.

- All disturbed areas will be reclaimed with plant species native to Utah, or seed mixtures approved by the BLM and our office, which may include the use of sterile, non-native, non-invasive, annuals to help secure topsoil and encourage native perennials to establish.

Level 1 CCAs:

- Avoid new surface disturbance, including well pads, roads, pipelines, or any other surface disturbing activities where feasible. Expansion of existing facilities will be allowed—e.g., widening existing access roads, expanding well pads, installation of pipelines to access existing facilities (along existing alignments or roadways).

- Where access roads are widened, well pads are expanded, or buried pipelines access existing facilities, design projects to minimize impacts by:

  - Locating project a minimum distance of 300 ft from individual *Sclerocactus* plants and/or populations (except for surface pipelines which is 50 ft),
  - Utilizing existing well pads and infrastructure,
  - Using common ROWs for roads and utilities where possible, and
  - Placing signing to limit off-road travel in sensitive areas.

- Where new surface disturbance occurs within the Level 1 CCAs, mitigation must be completed following the Conservation and Mitigation Strategy For the Pariette Cactus and Uinta Basin Hookless Cactus, Newfield Greater Monument Butte Project (Strategy).

- Where new surface disturbance directly affects *Sclerocactus* (*Sclerocactus* are directly removed), a monetary amount ($640 per *Sclerocactus*) will be contributed to the *Sclerocactus* Mitigation Fund-BLM to aid in the recovery of *Sclerocactus* species impacted by the project. These contributions are in addition to payments requested for indirect effects to *Sclerocactus*. Contributions will be negotiated between the Operator and the our office in consultation and will be based on the number of *Sclerocactus* directly impacted and in relation to our office's current management guidelines for *Sclerocactus*.

- Several options for mitigation of Level 1 CCAs are present (see Strategy). If mitigation funds are established, funds will be paid to:

  Sclerocactus Mitigation Fund – BLM
  Michelle Olson, Manager
  Impact-Directed Environmental Accounts National Fish and Wildlife Foundation
  Fifteenth Street NW, Suite 1100 Washington, DC 20005

Level 2 CCAs:

- New surface disturbance, including well pads, roads, pipelines, or any other surface disturbing activities will not exceed a 5 percent surface disturbance threshold where feasible.

- If the total cumulative surface disturbance is below the 5 percent threshold, and where access roads, buried pipelines, well pads, or other facilities requiring removal of vegetation (e.g., compressor stations) will be constructed, design project to minimize impacts by:

  - Locating project a minimum distance of 300 ft from individual *Sclerocactus* plants and/or populations (except for surface pipelines which is 50 ft).

- If the total cumulative surface disturbance is above the 5 percent threshold, and/or where new surface disturbance indirectly affects *Sclerocactus* (*Sclerocactus* within 300 ft of proposed disturbance), mitigation will occur following the Strategy.

- Where new surface disturbance directly affects *Sclerocactus* (*Sclerocactus* are directly removed), a monetary amount ($640 per cactus) will be contributed to the *Sclerocactus* Mitigation Fund-BLM to aid in the recovery of *Sclerocactus* species impacted by the project. These contributions are in addition to payments requested for indirect effects to cacti (see previous measure). Contributions will be negotiated between the Operator and our office based on the number of *Sclerocactus* directly impacted and in relation to the our current management guidelines for *Sclerocactus*.

- Several options for mitigation of Level 2 CCAs are available (see Strategy). If mitigation funds are established, funds will be paid to:

Sclerocactus Mitigation Fund – BLM
Michelle Olson, Manager
Impact-Directed Environmental Accounts National Fish and Wildlife Foundation 1133 Fifteenth Street NW, Suite 1100
Washington, DC 20005

Sclerocactus Habitat Polygon:

- Where access roads, buried pipelines, well pads, or other facilities requiring removal of vegetation (e.g., compressor stations) will be constructed, design project to minimize impacts by:
    - o Locating project a minimum distance of 300 ft from individual *Sclerocactus* plants and/or populations (except for surface pipelines, which is 50 ft).
- Where new surface disturbance indirectly affects *Sclerocactus* (Sclerocactus within 300 ft of proposed disturbance), mitigation will occur following the Strategy.
- Where new surface disturbance directly affects *Sclerocactus* (*Sclerocactus* are directly removed), a monetary amount ($640 per *Sclerocactus*) will be contributed to the *Sclerocactus* Mitigation Fund- BLM to aid in the recovery of *Sclerocactus* species impacted by the project. These contributions are in addition to payments requested for indirect effects to cacti (see previous measure). Contributions will be negotiated between the Operator and our office based on the number of *Sclerocactus* directly impacted and in relation to our current management guidelines for *Sclerocactus*.
- Several options for mitigation of the *Sclerocactus* Habitat Polygon are available (see Strategy). If mitigation funds are established, funds will be paid to:

    Sclerocactus Mitigation Fund – BLM
    Impact-Directed Environmental Accounts National Fish and Wildlife Foundation 1133 Fifteenth Street NW, Suite 1100
    Washington, DC 20005

Appendix B

2014 Ecological Restoration Mitigation Calculation Guidelines for impacts to *Sclerocactus wetlandicus* and *Sclerocactus brevispinus* Habitat

U.S. Fish and Wildlife Service, Utah Ecological Services Field Office
December 2014

Background:

The State of Utah ranks as the 10^{th} and 11^{th} largest producers nationally for gas and oil, and the majority of the state's production is centered in the Uinta Basin (Vanden Berg 2014). Total producing and active oil and gas wells in the Uinta Basin number more than 13,000, on 9,197 well pads (BLM 2012), with surface disturbance totaling more than 45,000 acres (assumes average of 5 acres of disturbance per well pad). Bureau of Land Management (BLM) analysis of 2011 data on pending NEPA projects forecasts more than 70,000 acres of additional oil and gas construction related disturbance in the next 15-20 years (BLM 2012). Current and projected energy development in the Uinta Basin overlaps with more than 90 percent of the range of the threatened Pariette cactus and Uinta Basin hookless cactus.

In 2012 we developed landscape scale conservation guidelines for the threatened Pariette cactus and Uinta Basin hookless cactus. The guidelines were developed to conserve and recover the species and prevent further habitat loss and fragmentation from energy development. Our strategy involved establishing core conservation areas (CCAs) that included dense aggregations of the threatened cactus species along with disturbance limits and pollinator buffers that allow for continued connectivity among these aggregations. The protection of pollinators and their habitat is important because these species depend primarily on pollination to produce seed. In order to further manage recovery of these cactus species across the landscape, our CCAs are grouped geographically into 8 Conservation Units in order to ensure genetic and ecological representation over the range of the species.

Level 1 CCAs include the densest aggregations of known cactus locations and were delineated based on a 400 m buffer around known plant locations (the buffer distance is based on foraging distances of primary pollinators; Tepedino 2010). Within these Level 1 CCAs our goal is to have no new surface disturbance; well pad and road expansion may be considered, but only after avoidance and minimization efforts along with appropriate compensatory mitigation. Level 2 CCAs are adjacent to Level 1 CCAs and include less dense aggregations of cactus, but are still considered important for overall population and habitat connectivity in the Uinta Basin. Level 2 CCAs were developed using a 1,000 m buffer around plants to allow for genetic connectivity and pollinator travel between Level 1 CCAs, and to provide additional habitat for cactus expansion and recruitment (Service 2012). Our goal is to maintain no more than 5 percent total surface disturbance within these Level 2 CCAs (Service 2012). Disturbance over 5 percent in Level 2 CCAs can occur once ecological restoration of disturbed habitat is completed so that disturbance stays at or below 5 percent. We recognize that some of the Level 2 CCAs are already above 5 percent surface disturbance. For these areas, we recommend that any disturbance above 5 percent in Level 2 CCAs be reclaimed to keep total disturbance at or below 5 percent and cumulative disturbance including areas that are reclaimed stay below 25 percent (Service 2012).

Reclamation of arid lands is difficult and full ecological restoration within the habitat of listed cactus species in Utah has not been successful (Grossl et al. 2012). We define full ecological restoration as supporting appropriate native community components and structure, returning land to a state with moderate to high ecological function that can support most processes and components of the pre-disturbance natural community, integrating into the surrounding landscape, resilient to environmental stressors, similar to a reference ecosystem (Society for Ecological Restoration (SER) 2004) and especially supporting listed plants and their habitat. Avoidance and minimization of impacts to listed species and their habitat is the first step in offsetting impacts.

Where impacts to listed plants and their habitats cannot be avoided or minimized we will consider ecological restoration as mitigation to offset these impacts. However, because we are currently unable to ensure successful ecological restoration, initial efforts will focus on researching restoration methods that may lead to improved techniques. As methods and inputs improve the estimated costs for restoration may change correspondingly. We have based the following 2014 mitigation costs on available information of the components needed for ecological restoration.

Ecological Restoration Components and Costs:

The following components are needed for ecological restoration of oil and gas impacts in the Uinta Basin:

1. *Treatment of non-native and invasive plants for 2 years.* Treatment and control of non-native plants is vital to reducing competition prior to establishing native plants (Sieg et al. 2003). Non-native and invasive plants increase dramatically in response to soil disturbance so treatment needs to be conducted before and after grading and re-contouring of well pads, roads and other disturbed areas (Sieg et al. 2003). These activities are required by BLM's Green River Reclamation Guidelines (see Objective 6; Attachment 1 *in* BLM 2011) so although we recognize that this activity is an important component of restoration we are not including them in our mitigation costs as long as they are implemented as part of BLM's requirements. Where these measures are not required as part of BLM reclamation requirements, these costs will apply in our mitigation calculation. Cost estimates were determined at \$0.02- \$0.03 per ft^2 (Musich Custom Spraying, Oct 29, 2014, personal communication) for a cost of \$1,307 per acre.

2. *Grading and plowing of disturbed site (well pad, road).* Well pads, roads and other disturbed sites result in soil loss and compaction (Buto et al. 2010). In addition, many sites are leveled so that the topography no longer matches the surrounding area thus leading to wind and water erosion, disruption of weathering processes, water path, sedimentation, barriers to species movement (Service 2010). Re-contouring disturbed sites to match surrounding topography integrates the restored area into the larger landscape and reduces negative impacts to ecological communities. Subsequent plowing is necessary to ensure a favorable recipient site prior to planting native seed or plants.

Re-contouring of disturbed sites is required by the BLM Green River District's Reclamation Guidelines (see Objective 2 and 3: Attachment 1 *in* BLM 2011). Where these measures are not required as part of BLM reclamation requirements, these costs will apply in our mitigation calculation.

Plowing of the site or similar soil improvement immediately prior to seeding is not required by BLM so we have incorporated it into our costs. We estimate that plowing costs will be $500 per acre given that heavy equipment will be needed to loosen soil in preparation for direct seeding and to provide necessary aeration and sufficient drainage for *Sclerocactus* species (J&L Oilfield Service Inc., Josh Justice, Oct 2, 2014, personal communication) and the low end cost for leveling well pads (~4 acres) is estimated at $2,000 per acre but average costs are $6,025 per acre (or $24,100 per well pad) which is the cost we are using for the mitigation calculation.

3. *Soil amendments including cobble, topsoil, char, wood chips, biological soil crust inoculant or other nutrients/minerals.* Restoring soils in arid lands is an important component for restoring and supporting native plant communities. Topsoil development in arid lands is an extremely slow process so once topsoil is removed amendments may be necessary to provide the appropriate organic and inorganic soil constituents needed support the biological community. (Whisenant 1995; Eldridge et al. 2012). In addition, we know that biological soil crusts are an important component of these arid ecosystesms so restoration will include re-establishment of biological soil crusts (Rosentreter and Belnap 2001; Bowker et al. 2005). This is an ongoing area of restoration ecology and we will likely learn more through experimentation and analysis. Current cost estimates for soil amendment were estimated to range from $1,200 to $6,000 per acre (Schneider 2014, Western States Reclamation, Inc,), and adding local topsoil would cost $300 per dump truck load (12 yards which covers 3,600 ft^2 at 1 inch depth) (All Red Paving, KW Trucking, Tri-County Concrete, Oct 2014, personal communication). Eleven truck loads are needed to cover one acre with one inch of soil amendment, costing $3,300 per acre. We are using the $3,300 per acre cost for our mitigation estimates.

4. *Collecting seed from a diversity of native plants.* Full restoration includes restoring the entire plant species composition that supports ecological functions and processes. Seed from native flowering plants will help increase diversity, and support pollinators with floral resources that are available at different times of year. Seed also needs to be collected from *Sclerocactus* in order to be able to propagate them for outplanting. Costs are estimated at $1,500 per acre as knowledgeable botanists and multiple trips are needed to gather seed from a diversity of species that best mimics intact site conditions.

5. *Planting seed from habitat specific native plants including wildflowers.* Establishing specific target native plants from the natural community where restoration is to occur is important in establishing the community components and processes (*i.e.*, pollination) important for a functioning ecosystem. Seed will be hand planted or drill seeded immediately after plowing or tilling of the site to ensure good seed-soil contact. Costs for this activity were estimated from two different sources ranging from $1,250 to $2,500 per

acre (Schneider 2014) and $500 to $1,000 per acre, or a median cost of $750 per acre (Mike Thomas, Great Bear Restoration, MT, Mar 2014, personal communication). We are using the $750 per acre cost for our mitigation estimates.

6. *Listed Sclerocactus species propagation.* Propagating and planting juvenile to young adult plants will help establish cactus on the restored area. *Sclerocactus* species can take 4-6 years from seed propagation before it can outplanted on a restoration site. Costs for propagating cactus were estimated by Red Butte Garden (R. Reisor, Feb 11, 2014, personal communication), and total $100 per cactus.

7. *Planting propagated Sclerocactus plants. Sclerocactus* that are propagated will be planted at 10 cacti per acre in Level 1 CCAs and 5 cacti per acre in Level 2 CCAs to establish listed *Sclerocactus* species at the restored site. We expect mortality and reduced reproduction from planted *Sclerocactus* so we anticipate final survival and reproduction of 8 *Sclerocactus* in Level 1 CCAs and 4 *Sclerocactus* per acre in Level 2 CCAs. Costs for planting cactus were estimated by Red Butte Garden (R. Reisor, Feb 11, 2014, personal communication) and total $42 per cactus. For restoration activities, five *Sclerocactus* plants would be planted per acre for a cost of $210 per acre.

8. *Planting commercially available habitat specific native plant species seed (twice) including grasses and shrubs.* This task would lead to the establishment of the portion of native plant community that would integrate formerly disturbed areas into the landscape, support ecosystem functions and stabilize the site. The BLM requires establishment of a desired self-perpetuating plant community in their Green River District Reclamation Guidelines (see Objective 1; Attachment 1 *in* BLM 2011) so we have not included these requirements in our mitigation costs. Where these measures are not required as part of BLM reclamation, these costs will apply in our mitigation calculation. In addition, only native, habitat specific plant species will be allowed in listed *Sclerocactus* habitat in order to achieve full ecological restoration. Costs include seed mix purchase and planting of seed. Costs for purchasing an appropriate seed mix are $500 per acre and include *Artemisia nova*, *Atriplex canescens*, *Pleuraphis jamesii*, *Achnatherum hymenoides*, *Linum lewisii* and *Sphaeralcea munroana* (J. Poulos Apr. 2014, personal communication). Costs for direct seeding are $750 per acre and are discussed above in number 5.

9. *Monitoring.* Monitoring of the restoration site is necessary to determine if the site is proceeding toward ecological restoration goals and to help inform management decisions to ensure restoration goals are met. Monitoring is required as part of BLM's Green River District Reclamation Guidelines (Objective 8) so we have not included them in our mitigation costs. However, we will work with BLM on a project-specific basis to determine the goals, objectives, and requirements of restoration monitoring plans. Where these measures are not required as part of reclamation these costs will apply in our mitigation calculation.

Calculating Acres to be Mitigated:

Mitigation costs are based on the amount of habitat impacted and the quality of that habitat as determined by the U.S. Fish and Wildlife Service and delineated into 3 strata: Level 1 CCAs, Level 2 CCAs, and suitable habitat outside of the CCAs. Mitigation is applied only where impacts cannot be avoided. Mitigation will occur for any impacts occurring within Level 1 CCAs for any surface disturbances. Mitigation will occur in Level 2 CCAs where surface disturbance exceeds 5 percent. Mitigation will occur in suitable habitat where impacts are within 300 ft of listed *Sclerocactus* plants. This habitat mitigation approach does not apply to direct impacts to listed plants. Mitigation for direct impacts are addressed through another mitigation calculation as discussed below.

The amount of habitat impacted will be calculated as follows:

1. For Level 1 CCAs all disturbed acres inside designated Level 1 CCAs will be mitigated. To meet our objective of no disturbance in Level 1 CCAs, we anticipate the only additional disturbance will come from well expansions not new roads or well pads.
2. For Level 2 CCAs the number of acres currently disturbed that are not reclaimed, and exceed the 5 percent disturbance cap will be mitigated.
3. For impacts outside of Level 1 and 2 CCAs and within 300 ft of *Sclerocactus*:
    a. The total acreage of the well pad that is within 300 ft of *Sclerocactus* will be mitigated.
    b. The distance of the Right-of-Way (ROW) where the edge is within 300 ft of *Sclerocactus* for buried and cross country pipelines and 50 ft for hand-laid surface pipelines adjacent to roads multiplied times the width for the stretch of ROW (for a pipeline or road) will be mitigated.

Summary of Mitigation Costs:

Mitigation costs include topographical contouring, soil preparation, seed collection and planting, cactus propagation and planting, and monitoring. These costs vary based on the importance of the three habitat areas for *Sclerocactus*—Level 1 CCAs, Level 2 CCAs, and Suitable Habitat outside of CCAs.

Level 1 CCAs: Mitigation costs per acre in Level 1 CCAs includes costs associated with plowing the soil, amending the soil, propagating *Sclerocactus* and planting at a density of 10 cacti per acre, and collecting seed and planting a diversity of native plant species from adjacent sites. Level 1 CCAs areas support the highest density of *Sclerocactus* thus we have included costs for restoring a high density at 10 *Sclerocactus* per acres assuming some mortality and reduced reproduction from transplanting and poor soils.

Level 2 CCAs: Mitigation costs per acre in Level 2 CCAs includes costs associated with amending the soil, propagating *Sclerocactus* and planting at a density of 5 cacti per acre and collecting seed and planting a diversity of native plant species from adjacent sites.

Suitable habitat: Mitigation costs per acre in suitable habitat includes costs associated with collecting and planting a diversity of native seed and re-establishing biological soil crust by inoculation.

Other costs associated with restoration that are already required and included in BLM's Green River Reclamation Guidelines such as grading of site and seeding and establishment of common native plants commercially available are not included in our mitigation costs because we assume these restoration actions will be conducted as part of BLM's requirements. Where these actions are not required or completed these costs will be included in our total costs for mitigation.

Table 1. ***Sclerocactus*** **compensatory mitigation calculation**

Mitigation habitat type	**Acres**	**Cost per acre**	**Explanation of restoration costs**
Level 1 CCA (any level of disturbance)	1.0	$7,510.00	Includes amending soil, cactus propagation and planting (10 cacti per acre), and native species seed collection and planting. Assumes costs for BLM required measures are already being implemented.
Level 2 CCA (over 5% disturbance or within 300 ft of cactus)	1.0	$6,260.00	Includes amending soil, cactus propagation and planting (5 cacti per acre), and native species seed collection and planting. Assumes costs for BLM required measures are already being implemented.
Sclerocactus habitat (Disturbance within 300 ft of cactus)	1.0	$2,550.00	Native species seed collection and planting and biological soil crust inoculation. Assumes costs for BLM required measures are already being implemented.

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United States Department of the Interior

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IN REPLY REFER TO:
3160, 6841 (UTG010)

MEMORANDUM

To: Larry Crist
Utah Supervisor, Utah Field Office, Ecological Services,
U.S. Fish & Wildlife Services, Salt Lake City, Utah

From: Michelle Brown Michelle Brown
Acting District Manager, Green River District

Subject: Request to Initiate Formal Consultation on Newfield Exploration Corporation Monument Butte Oil and Gas Development Project in Uintah and Duchesne Counties, Utah Environmental Impact Statement

Attached is the Biological Assessment (BA) for the Newfield Exploration Company Monument Butte Oil and Gas Development Project Environmental Impact Statement (EIS). Pursuant with Section 7 of the Endangered Species Act (ESA) of 1973, and in conformance with 50 CFR Part 402.12, we are requesting initiation of Formal Section 7 consultation on federally listed species within the Project Area.

Background

Newfield Exploration Company (Newfield) has notified the United States (U.S.) Bureau of Land Management's (BLM) Vernal Field Office (VFO) of its need to expand their ongoing oil and natural gas development within and in the vicinity of the Greater Monument Butte Unit (GMBU). Newfield proposes to implement a plan to fulfill its obligations and responsibilities under federal leases to explore, develop, and produce commercial quantities of oil and natural gas. The Monument Butte Project Area (MBPA) is located in southeastern Duchesne County and southwestern Uintah County. The MBPA consists of approximately 119,743 acres located in Township 4 South, Range 1 East; Township 5 South, Range 3 West; Township 8 South, Range 15-19 East; Township 9 South, Range 15-19 East; and Township 10 South, Range 15-18 East.

The EIS has analyzed four alternatives: the project proponent's Proposed Action Alternative (Alternative A), the No Action Alternative (Alternative B), the Field-Wide Electrification Alternative (Alternative C), and the Agency Preferred Alternative (Alternative D).

The Agency Preferred Alternative (Alternative D) would include the following components:

- Development of approximately 750 new Green River vertical oil wells to be drilled from a combination of new, small and large well pads, all of which would eventually be converted into waterflood injection wells;

- Development of approximately 2,500 new deep gas wells that would be vertically or directionally drilled from a combination of new and existing, large well pads;

- Development of approximately 2,500 new 20-acre downhole spacing Green River oil production wells to be directionally drilled from a combination of new or existing, small and large well pads.

- Construction of approximately 226 miles of new 100-foot-wide ROW that would be used for new road construction (40-foot width) and pipeline installation (60-foot width). Up to 70-foot-wide expansion along approximately 318 miles of existing access road ROW that would be used for road upgrade (10-foot width) and pipeline installation (60-foot width);

- Construction of 20 new compressor stations for deep gas well development;

- Expansion of three existing Green River oil well compressor stations and construction of one new compressor station for gas associated with Green River oil well development;

- Construction of up to one 50-MMscf/d centralized Green River oil well gas processing plant;

- Construction of up to 13 gas driven water treatment and injection facilities for management and distribution and injection of produced water;
- Construction of up to 12 GOSPs for oil and produced water collection;

- Development of one fresh water collector well for waterflood operations; and

- Construction of six water pump stations.

Initial surface disturbance would occur during and after the construction, drilling, completion, and testing activities. Prior to interim reclamation, initial surface disturbance for well pads, access roads, pipeline ROWs, and other surface facilities would equal approximately 10,122 acres. Those portions of the well pads, access road ROWs, pipeline ROWs, and other facilities not needed for production operations would be reclaimed within two to three growing seasons, assuming optimal conditions are present. The remaining surface disturbance would be residual or "long-term" disturbance of approximately 4,978 acres during the life of the project.

Pariette Cactus (*Sclerocactus brevispinus*) and Uinta Basin Hookless Cactus (*Sclerocactus wetlandicus*)

Pariette Cactus

Pariette cactus (*S. brevispinus)* is a perennial that occurs as a solitary, unbranched, egg-shaped to short cylindric succulent stem, usually 0.75–2.75 inches in diameter by 1 to 3 inches tall, that produces pink to purplish flowers from late April to May (Heil and Porter 2004). The Pariette cactus is distinguished from Uinta Basin hookless cactus by its spherical shape, short-hooked or absent central spines, smaller stature, flower size, and retention of juvenile vegetative characteristics in adult flowering plants (Heil and Porter 2004).

The Pariette cactus occurs on fine soils in clay badlands derived from the Uinta Formation within sparsely vegetated salt desert shrubland that is dominated by shadscale, rabbitbrush, and horsebrush from 4,600 to 4,900 feet amsl (USFWS 1990, Heil and Porter 2004). One of the reasons for the susceptibility of Pariette cactus to irreversible population reduction is its specific requirement for habitat with a high percentage of channels on the surface, which form a "desert pavement." Surface disturbance and construction cause the damage or removal of this unique soil substrate, which makes reclamation challenging.

The conservative minimum estimate for the total population of *S. brevispinus* is somewhere in the range of 22,000-29,000 plants within a 204-square-mile (75,400-acre) area from the Pariette Draw along the Duchesne-Uintah County boundary (USFWS 2012b). Suitable habitat for *S. brevispinus* is not continuous across this area; it is irregularly distributed across the landscape within the area identified as potential habitat. The total area of potential habitat for Pariette cactus is estimated to be about 31,000 acres on BLM lands, and approximately 17,960 acres on Ute Tribal lands (USFWS 2012b). Of the potential *S. brevispinus* habitat on BLM land, 100 percent has been leased for oil and gas development by Newfield Exploration Company and Newfield Energy, which includes the MBPA (USFWS 2012b).

Uinta Basin Hookless Cactus

The Uinta Basin hookless cactus (*S. wetlandicus)* is a perennial that occurs as a solitary, unbranched, round-to-elongate/cylindric succulent stem, usually 1.25–3.5 inches in diameter by 2 to 5 inches tall, that produces pink to violet flowers from late April to May (Heil and Porter 2004). Observed pollinators include bees, beetles, ants, and flies. Seed dispersal vectors include gravity, ants, birds, rodents, precipitation, and surface water flows. It is theorized that seed dispersal is a limiting factor in the distribution of the species (USFWS 1990). Very little is known about the factors affecting the distribution and long-term population dynamics of the Uinta Basin hookless cactus.

Information on the habitat requirements and distribution of this species has been rapidly changing as more studies and surveys are conducted in the Uinta Basin. Currently, the species is known to occur on Quaternary and Tertiary alluvium soils overlain with cobbles and pebbles of the Duchesne River, Green River, and Uinta Formations between 4,500 to 6,600 feet amsl (BLM 2008b, UNPS 2007). It is also found on gravelly hills and terraces, river benches, valley slopes, and rolling hills along the Green, White, and Duchesne Rivers. Preferred habitat is generally associated with Pleistocene outwash terraces with coarse-textured, alkaline soils overlain by a surficial pavement of large, smooth, rounded cobble. It can be found in a range of vegetative communities, including clay badlands, salt desert shrub, and pinyon-juniper woodlands. Associated species include black sagebrush, shadscale saltbush, James' galleta, and Indian ricegrass.

In 2010, the USFWS developed a potential habitat polygon for *S. wetlandicus* and *S. brevispinus* to better assess possible impacts to the species within its range. Although *S. wetlandicus* and *S. brevispinus* populations can be found outside of these areas, they tend to occur at greater numbers and at higher densities within these polygons. The potential habitat polygon is updated annually and was last updated in March 2013 (USFWS 2013).

The total area of potential habitat for *S. wetlandicus* is currently 442,000 acres and includes federal, tribal, state, and private surface lands. Recent geographic data for *S. wetlandicus* includes more than 18,400 points, representing approximately 40,528 individual cacti. Approximately 57,442 acres of USFWS-designated potential habitat for the *S. wetlandicus* has been identified within the MBPA.

Impacts

One of the primary objectives of Alternative D is to reduce surface disturbance within *Sclerocactus* habitat and specifically, within the Upper and Lower Pariette Core Conservation Areas. However, for analysis purposes, the Alternative evaluated the most conservative (i.e., worst-case) scenario. Under this conservative scenario, implementation of Alternative D could directly result in the disturbance of approximately 4,295 acres of potential habitat for *Sclerocactus* species within the MBPA, which represents approximately 1 percent of the total potential habitat for *Sclerocactus* species across their entire range. Following construction, approximately 2,201 acres (51 percent) of land associated with the construction of the well pads, access roads, and pipeline ROWs not needed for operation purposes would be reclaimed. If reclamation is successful, the long-term disturbance to *Sclerocactus* species' habitat under Alternative D would be reduced to approximately 2,094 acres.

Under Alternative D, no new surface disturbance or well pad expansions would occur within Level 1 Core Conservation Areas except as allowed under the FWS/Newfield Conservation, Restoration, and Mitigation Strategy for the Pariette and Uinta Basin Hookless Cactus. Per the strategy in Level 1 areas, there could be approximately 116 acres of new disturbance from limited well pad expansions and pipelines buried adjacent to existing roads and up to 20 acres of new disturbance from eight new well pads. In Level 2 areas, GIS calculations show conceptually mapped disturbance of approximately 210.8 acres of disturbance. Surface disturbance in Level 2 areas would be minimized to the greatest extent practicable by using existing infrastructure (i.e., access roads and pipelines) and directional drilling from multi-well pads that would either require the expansion of existing well pads or the construction of a limited number of new multi-well pads. Concentrated use of existing well pads would reduce fragmentation of *Sclerocactus* habitat. If reclamation is successful, the long-term disturbance to Level 1 and Level 2 Core Conservation Areas under Alternative D would be reduced to approximately 57 acres and 583 acres, respectively. Similarly, Alternative D's focused use of existing well pads would reduce the level of habitat fragmentation from new roads and pipeline corridors.

Indirect and dispersed direct effects to *Sclerocactus* species under Alternative D could include an increased potential for the invasion and establishment of noxious weed species. Invasion by non-native species is particularly problematic as they are capable of effective competition with native species for space, water, light, nutrients, and subsequent survival. Over time, the successful establishment of non-native species can choke out native vegetation and eventually dominate large areas. An increase in weedy annual grasses also increases the potential for fire by increasing the density and flammability of available fuels. Grasses are more flammable and establish in denser populations than woody and non-woody native vegetation.

Additional indirect construction-related impacts could include an increased potential for wind erosion of disturbed areas, creating airborne dust that could be transported into suitable habitat for these species. Airborne dust generated by vehicles could inhibit photosynthesis and transpiration in these species. Inhibited and reduced rates of photosynthesis could affect the rate of growth, the reproductive capacity of individual plants, and ultimately the ability of these individuals to persist in adjacent areas. Thompson et al. (1984) and Farmer (1993) have indicated that varying amounts of dust settling on vegetation can block stomata, increase leaf temperature, and reduce photosynthesis.

Other indirect impacts to *Sclerocactus* species could include impacts from the use of herbicides to control invasive plants in the MBPA, and possible reductions in pollination or seed dispersal from a larger road network that could result in isolation of populations due to habitat fragmentation and increased dust. Because *Sclerocactus* species require insect pollinators for successful reproduction (Tepedino et al. 2010), impacts to pollinator nesting and foraging habitats can negatively affect the cactus by reducing the diversity and abundance of pollinators, and, thereby, the plant's ability to successfully reproduce. Expansion of access roads also could also increase the risk of illegal collecting of Sclerocactus species.

Determination for Pariette Cactus and Uinta Basin Hookless Cactus

Although these measures would minimize the impacts of the action to *Sclerocactus* species, larger landscape-level changes, such as increased habitat fragmentation and habitat loss, pollinator disturbance, changes in erosion and water runoff, and increased weed invasion, cannot be entirely negated. These disturbances could continue to negatively impact *Sclerocactus* species throughout the MBPA. An undetermined number of individual plants could be lost; therefore, implementation of Alternative D ***"may affect, is likely to adversely affect"*** the Uinta Basin hookless cactus and Pariette cactus and their habitats.

Ute ladies'-tresses (*Spiranthes diluvialis*)

Ute ladies'-tresses (*Spiranthes diluvialis*) is a federally listed threatened species. A member of the orchid family, this perennial herb occurs on seasonally flooded river terraces, spring-fed stream channels, lakeshores, and in human-modified and disturbed wetlands such as canals, gravel pits, and irrigated meadows (Fertig et al. 2005). Within the Uinta Basin, Ute ladies'-

tresses occurs along the Green River near the confluence with the Yampa River, and along Ashley Creek, Big Brush Creek, and the upper Duchesne River and its tributaries (BLM 2005a) above 4,300 feet amsl (BLM 2006b). Ute ladies'-tresses populations require recurrent disturbance, such as seasonal flooding, grazing, or mowing for establishment and persistence and often occur in recently created riparian habitats such as sand bars and backwaters (USFWS 1995a).

Impacts

There are no documented occurrences of Ute ladies'-tresses in the MBPA. Habitat for the Ute ladies'-tresses in the MBPA is generally confined to portions of the Pariette Wetlands. While the presence of wetlands is an important habitat quality for this species, the wetland vegetative cover includes open water and greasewood flats that do not represent suitable habitat for Ute ladies'-tresses. Direct disturbance to potential habitat for this species is unlikely, because no disturbance to wetlands or riparian areas in the Pariette Area of Critical Environmental Concern (ACEC) is expected to occur under implementation of Alternative D. For the same reasons, the potential for occurrence of indirect and dispersed direct effects to this species from Alternative D would be unlikely to occur.

The species-specific conservation measures for Ute ladies'-tresses include provisions to avoid occupied habitat, to employ the use of spatial buffers between surface activities and known populations of plants, and to monitor the effectiveness of these measures.

Determination for Ute Ladies'-tresses

No loss of individual plants is anticipated through implementation of Alternative D, nor is Alternative D anticipated to impact suitable habitat for this species. Therefore, Alternative D "***may effect, is not likely to adversely affect***" the Ute ladies'-tresses.

Colorado River Fish Species

Colorado pikeminnow

The Colorado pikeminnow (*Ptychocheilus lucius*), formerly the Colorado squawfish, is a federally endangered fish species under the ESA. This species is endemic to the Colorado River Basin habitats that are characterized by variable flow, turbulent water, and high silt loads. Within the Colorado River Basin, the Colorado pikeminnow is known to inhabit the Colorado, Green, Duchesne, Price, San Rafael, Gunnison, San Juan, White, and Delores Rivers and numerous associated streams. Today, the species is most abundant in the Green River below the confluence with the Yampa River; the White River from Taylor Draw Dam near Rangely, Colorado, downstream to the confluence with the Green River; and the main stem of the Colorado River from Palisade, Colorado, to Lake Powell. The Gray Canyon and the Yampa River of the lower Green River hold the two critical spawning sites of this species (USFWS 2002b).

The USFWS has designated a total of 726 river miles in Utah as critical habitat for the Colorado pikeminnow. This critical habitat occurs in portions of the Green, Colorado, White, and San Juan Rivers and their respective 100-year floodplains, including portions of the Green River that flow east of the MBPA (USFWS 2007a).

Bonytail Chub

The bonytail chub (*Gila elegans*) is a federally endangered fish under the ESA. The bonytail chub has historically been a common species along the Colorado River system, but the population has dwindled in recent years (USFWS 1994). This may be due to the introduction of 40 non-native species of riverine fish such as the green sunfish, smallmouth bass, and channel catfish. The bonytail chub is adapted to major river habitats, where it has been observed in slow moving pools and eddies. Flooded bottomland habitat is important for growth and conditioning for young bonytail chub and acts as a nursery or transitioning habitat. There are currently no self-sustaining wild populations of bonytail chub. While very few individuals have been caught in the Upper Colorado River Basin, there have been several individuals caught in the Green River at Hideout Canyon and Gray Canyon, and at the confluence of the Colorado and Green Rivers. The release of hatchery-born bonytail chub into the Upper Colorado River Basin has resulted in low survival, reproduction, and recruitment to the population (USFWS 2002c).

In Utah, the USFWS has designated a total of 139 river miles and their associated 100-year floodplains as critical habitat for the bonytail chub in portions of the Green River and Colorado River. The closest designated critical habitat is located in the Green River, approximately 20 miles downstream from the MBPA (USFWS 2007a).

Razorback Sucker

The razorback sucker (*Xyrauchen texanus*) is a federally endangered fish species under the ESA. The razorback sucker currently populates the Green River, upper Colorado River, and San Juan River subbasins in the Upper Colorado River Basin. The general population consists of mostly aged adults with minimal recruitment; however, in the middle Green River, where there are juveniles and young adults, there is a low degree of recruitment. The largest population of razorback sucker exists in low-gradient, flat-water reaches of the middle Green River between the confluences with the Duchesne River and the Yampa River (USFWS 2002d). Razorback suckers tend to occupy habitat types such as impounded and riverine areas, eddies, gravel pits, flooded mouths and tributary streams, backwaters, flooded bottoms, and sandy riffles. Adults move into flooded areas in spring to begin spawning migrations as they become reproductively active. Spawning typically occurs over rocky runs and gravel bars (USFWS 2002d).

The USFWS has designated a total of 688 river miles in Utah as critical habitat for the razorback sucker. This critical habitat occurs in portions of the Green, Colorado, Duchesne, White, and San Juan Rivers and their respective 100-year floodplains, including portions of the Green River that flow east of the MBPA (USFWS 2007a).

Humpback Chub

The humpback chub (*Gila cypha*) is listed as federally endangered fish species under the ESA. In Utah, individuals have inhabited riverine areas from the Upper Green River near Desolation Canyon down to the lower Yampa River, the White River, and the Colorado River below the Glen Canyon Dam. Humpback chub are found in river canyons, where they occupy habitats such as river pools, riffles, eddies, rocky runs, and travertine dams. The densest concentrations of humpback chub are in the Westwater Canyon and Grand Canyon reaches of the Colorado River. Humpback chub in the Desolation and Gray Canyons of the Green River hold the third most abundant population of this species (USFWS 2002e).

In Utah, the USFWS has designated a total of 139 river miles and their associated 100-year floodplains as critical habitat for the humpback chub in portions of the Green River and Colorado River. The closest designated critical habitat is located in the Green River approximately 20 miles downstream from the MBPA (USFWS 2007a).

Impacts

Alternative D activities would result in direct and indirect impacts to Colorado River endangered fish species (i.e., bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker) and their habitats. The principal impacts to these species likely to be associated with Alternative D include: (1) flow depletion due to project-related water use; (2) increased sedimentation of the Green River; and (3) an increased risk of accidental spills of pollutants such as natural-gas condensate and oil into the Green River or its tributaries. The magnitude of these impacts to Colorado River endangered fish species would depend on a number of factors, including the type and duration of disturbance, time of year, and implementation of recommended and required mitigation measures. The severity of these impacts to Colorado River endangered fish species would depend on a number of factors, including the type and duration of disturbance, time of year, and implementation of recommended and required mitigation measures.

Water depletion also may affect aquatic habitats and fisheries resources within these watersheds. Water requirements for drilling, hydrostatic testing, dust abatement, and other project activities would be acquired from permitted sources. These sources may include direct withdrawals from the Green River, Pariette Draw, municipal sources, and local supply wells. Existing authorized water usage would directly and indirectly consume water from the Green River and ultimately cause reductions in flow within the Colorado River Basin.

The Colorado River fish are affected by activities that deplete or degrade the flow of downstream waters into the Upper Colorado River Basin (USFWS 1987). In addition to reducing the quantity of water with sufficient quality in a specific location, water depletions can also reduce a river's ability to create and maintain the physical habitat (areas inhabited by, or potentially inhabitable by, special status fish for use in spawning, nursery, feeding, and rearing, or access to these habitats) and the biological environment (food supply, predation, and competition). Water depletions can also contribute to alterations in flow regimes that favor non-native fish that compete with native fish species for resources.

It is estimated that total water use in drilling and completion of up to 5,750 wells under Alternative D would be approximately 1,150 acre-feet of water annually. Additionally, it is estimated that Newfield would use approximately 36 acre-feet of water per year for dust abatement during project operations and up to 2,738 acre-feet per year for water-flooding operations. Thus, total water use under Alternative D would average approximately 2,774 acre-feet annually over the 20- to 30-year construction and operational period.

On January 22, 1988, a Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (Recovery Program) was initiated to address depletion and other impacts to the Colorado River fish. Any water depletions from tributary waters within the Colorado River drainage are considered to "jeopardize the continued existence" of these fish under this Recovery Program. A Section 7 agreement was implemented on October 15, 1993, by Recovery Program participants to further define and clarify objectives of the recovery process as stated in the Recovery Program. Incorporated into this agreement was the Recovery Implementation Program Recovery Action Plan (RIPRAP). The RIPRAP identified actions currently believed to be required to recover the Colorado River fish most expeditiously. Included in the RIPRAP was the requirement that a one-time depletion fee would be paid to help support the Recovery Program for all non-historical water depletions from the Upper Colorado River Basin. These depletion fees were intended to be a Reasonable and Prudent Alternative to avoid jeopardy to the endangered Colorado River fish by depletions to the Upper Colorado River Basin. In 1995, USFWS eliminated these water depletion fees for water depletions from the Upper Colorado River Basin of 100 acre-feet per year or less (USFWS 1995b).

Newfield currently has secured water rights for up to 5,106 acre-feet per year. Of this volume, 324 acre-feet are from water sources considered historic depletions under the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (USFWS 1987). Section 7 consultation was completed for all historic depletions in 1993 (USFWS 1993). As part of this consultation, it was determined that historic depletions, regardless of size, do not pay a depletion fee to the Recovery Program. Newfield's additional water sources (WR 41-3530; WR 47-1802; WR 47-1804) are not considered historic depletions and Section 7 consultation with the USFWS is required prior to use of these sources. To date, three consultations have been completed for water depletions associated with oil and gas development projects in the MBPA. Currently, a total annual volume of 3,328 acre-feet has been authorized through USWFS consultations. Water supply sources used under these previous consultations, plus the historic water rights, makes a total of 3,652 acre-feet of water available for this Project. The additional 273 acre-feet of water needed under Alternative D would require additional consultation.

Potential impacts to Colorado River fish from construction and operation of the proposed water collection station would include short-term disturbance of about 1 acre of floodplain habitat, which could result in erosion and sediment yield. Impingement at the intakes is not anticipated as a result of the use of screening. Hydrocarbons located at the nearby (but outside of the floodplain) water processing station would be limited to produced natural gas or NGL that would be used as a fuel source to power the 300 to 600 hp generator associated with the processing station. Therefore, there is a low risk of leaks or spills from hydrocarbons associated with the water collection station to impact fish.

Implementation of Alternative D could also degrade USFWS-designated critical habitat for Colorado River fish in the Green River by increasing erosion and sediment yield. Sediment deposition may bury and suffocate fish eggs and larvae affecting spawning and rearing, while reduced visibility created by sediment load may inhibit the ability of fish to see prey, impacting feeding behavior (USEPA 2003). Physiological impacts, such as gill clogging and the ingestion of large quantities of sediment, could also cause illness, reduced growth, and eventual death (USEPA 2003). Due to existing surface disturbance, ongoing projects, and poor reclamation success of previously disturbed areas within the MBPA and surrounding region, increased erosion and subsequent sediment yield are likely to occur within these watersheds.

Sediment could be delivered to several perennial streams, riparian habitats, and small, ephemeral drainages (i.e., Castle Peak Draw, Wells Draw, Big Wash, Sheep Wash) within the MBPA. Conservatively, assuming that all sediment delivered to Pariette Draw and other drainages within the MBPA is eventually transported to the Green River, Alternative D would increase sediment loading to the Green River by about 66 tons annually, or by approximately 0.001 percent in the short-term.

Activities within or adjacent to the 100-year floodplains of Pariette Draw and the Green River, or within drainages leading to these watercourses, may increase the potential for a release of contaminants into these areas. Leaks or spills of contaminants may lead to habitat degradation and mortality of fish. The risk of acute or chronic toxicity to endangered fish in the Green River in the event of a natural-gas condensate spill would depend on the location of the spill relative to the main stem Green River. Natural gas condensate contains a variety of lightweight hydrocarbons, of which the most toxic to aquatic biota is the aromatic hydrocarbon fraction (benzene, ethylbenzene, toluene, xylenes). These account for less than 0.5 percent of the volume of condensate (BLM 2005b). Natural-gas condensate is highly volatile and likely to evaporate within approximately 8 hours of spilling (BLM 2005b). Thus, spills occurring in close proximity to the Green River, or in streams with flow rates that would deliver condensate to the Green River prior to evaporation, would pose a risk of exposing Colorado River fish to potentially lethal levels of toxic substances.

Under Alternative D, pipelines would cross ephemeral streams at approximately 1,046 locations within the MBPA. Because the crude oil extracted within the MBPA is solid within the temperature range of the area's climate, oil would not pose a risk of acute toxicity for Colorado River endangered fish in the event of an accidental spill. A catastrophic spill of a 400-barrel (16,800-gallon) condensate tank within the 100-year floodplain of the Green River, while highly unlikely, would have a high probability of producing acutely toxic concentrations of condensate in the Green River, and therefore is considered a possible adverse impact to Colorado River fish. A spill from a condensate tank within the Green River floodplain would constitute the overall worst case scenario under the Proposed Action and would likely result in acute toxicity at some flow levels and an adverse impact to designated critical habitat.

ACPEMs and BMPs for the site-specific use of buried pipelines and centralized water and condensate tank facilities (where they were determined to be appropriate at the site-specific level) would reduce the risk of spills from pipelines and tanks. Burying pipelines would reduce the risk of accidental puncture of pipelines, and central tanks batteries could be located outside the floodplain, greatly reducing the risk of spills affecting the Green River. Surface disturbance in riparian habitats and the floodplain would be limited to the water collector well. Therefore, the potential for a release of contaminants into the main stem of the Green River, and subsequent increased risk of acute or chronic toxicity to endangered fish in the Green River in the event of a natural-gas condensate spill is considered to be low. The proposed mitigation measures described below would preclude the development of wells in the floodplain.

Determination for Colorado River System Threatened and Endangered Fish

Based on the projected water depletions and the increase in yields of the Green River, implementation of Alternative D ***"may affect, is likely to adversely affect"*** the listed Colorado River fish species, bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker and their habitat. The loss or "take" of an unknown number of individual fish would be anticipated. The potential also exists that portions of the designated critical habitat for these species may be adversely modified.

Western Yellow-Billed Cuckoo (*Coccyzus americanus*)

The western yellow-billed cuckoo (WYBC) (*Coccyzus americanus*) is listed as a threatened species under the ESA. This species is a neotropical migratory species that breeds in the U.S. and Canada and winters in South America (USFWS 2001). Currently, the range of the cuckoo is limited to disjunct fragments of riparian habitats from northern Utah, western Colorado, southwestern Wyoming, and southeastern Idaho, southward into northwestern Mexico, and westward into southern Nevada and California. Cuckoos are long-range migrants that winter in northern South America in tropical deciduous and evergreen forests (Ehrlich et al. 1988).

Historically, cuckoos were probably common to uncommon summer residents in Utah and across the Great Basin (Ryser 1985, Hayward et al. 1976). The current distribution of WYBCs in Utah is poorly understood, though they appear to be an extremely rare breeder in lowland riparian habitats statewide (Walters 1983, Behle 1981, Benton 1987).

WYBCs are one of the latest migrants to arrive and breed in Utah. They arrive in extremely late May or early June and breed in late June through July. Cuckoos typically start their southerly migration by late August or early September. WYBCs feed almost entirely on large insects that they glean from tree and shrub foliage. They feed primarily on caterpillars, including tent caterpillars. They also feed frequently on grasshoppers, cicadas, beetles, and katydids, occasionally on lizards, frogs, and eggs of other birds, and rarely on berries and fruits (Ehrlich et al. 1988, Kaufman 1996).

The cuckoo is a riparian obligate bird that feeds in cottonwood groves and nests in willow thickets. Nesting habitat is classified as dense lowland riparian that is characterized by a dense sub-canopy or shrub layer (regenerating canopy trees, willows, or other riparian shrubs) within 300 feet of water. Overstory in these habitats may be either large, gallery-forming trees (30 to 90 feet in height) or developing trees (10 to 30 feet in height), usually cottonwoods. No USFWS proposed critical habitat for this species occurs within the GMBU Project Area. Nesting habitats are found at low to mid-elevations (2,500 to 6,000 feet amsl) in Utah. Cuckoos may require large tracts (100 to 200 acres) of contiguous riparian nesting habitat; however, cuckoos are not strongly territorial and home ranges may overlap during the breeding season. Nests are usually 4 to 8 feet above the ground on the horizontal limb of a deciduous tree or shrub, but nest heights may range from 3 to 20 feet and higher. In Utah, this species nests in riparian areas and has been documented in cottonwood habitat along the Green River.

Impacts

The Western yellow-billed cuckoo (WYBC) is an obligate riparian species that nests and forages in cottonwood-willow woodlands with a dense sub-canopy. While there is a low potential for the species to occur within the MBPA, their presence within the area cannot be entirely discounted. Riparian habitat that could be used by the WYBC occurs on the eastern edge of the MBPA along the Green River and within isolated portions of Pariette Draw.

The overall initial surface disturbance to Rocky Mountain Lower Montane Riparian Woodland and Shrubland vegetation, which serves as potential nesting and foraging habitat for cuckoo, would be approximately 1 acre. If development or production activities were to occur during the cuckoo's breeding season (March through July), direct impacts could result in loss of nests, eggs, or young, or the disruption of breeding activities for that season. The magnitude of potential impacts would be considerably minimized under Alternative D, as few new well pads would be constructed, the amount of new surface disturbance would be minimized through the increased use of multi-well pads and directional drilling technology, limited surface disturbance or well pad expansions would be allowed on federal lands within the Pariette Wetlands ACEC, and surface disturbance within riparian and 100-year floodplain habitats would be limited to the water collector well. No surface disturbance would occur within proposed critical habitat for the WYBC.

These habitat areas are located within the 100-year floodplain of Pariette Draw and the Green River in the extreme northeastern corner of the MBPA. Under existing regulations, guidelines, and ACEPMs, well pads and associated roads and pipelines would be located to avoid or minimize impacts in riparian areas and the 100-year floodplain of Pariette Draw and the Green River, and appropriate erosion control and revegetation measures would be employed.

Indirect impacts to the species include displacement due to increased human presence in the area and the associated increase in noise, traffic, and dust levels, and increased invasion of non-native plants into suitable habitat. Invasion of riparian habitats by aggressive non-native species, particularly tamarisk (*Tamarix* species), would adversely impact the species. Other potential indirect impacts to the species include decreased water quality and degradation of riparian vegetation, due to erosion and sedimentation associated with surface disturbance.

Determination for Western Yellow-Billed Cuckoo

Because implementation of Alternative D would directly impact only 1 acre of suitable WYBC habitat, it constitutes a negligible percentage of suitable habitats available throughout the range of this species. In addition, the mitigation measures listed below would require WYBC surveys before any surface disturbance or drilling occurs in WYBC habitat during the breeding and nesting season. Therefore, implementation of Alternative D ***"may effect, is not likely to adversely affect"*** the threatened WYBC.

Greater Sage-Grouse (*Centrocercus urophasianus*)

Widespread declines in greater sage-grouse populations throughout the West led to a petition to list the species as threatened under the ESA. Based on accumulated scientific data and new peer-reviewed information and analysis (USFWS 2010c), the USFWS published a finding in the *Federal Register* (50 CFR 17) on March 5, 2010, stating that the greater sage-grouse warrants the protection of the ESA, but listing the species is precluded by the need to address higher-priority species first. The greater sage-grouse was placed on the candidate list for future action, meaning that the species will not receive statutory protection under the ESA at this time, and states will continue to be responsible for managing the species. The species is currently listed as a BLM sensitive species.

In Utah, the greater sage-grouse inhabits upland sagebrush grasslands, foothills, and mountain valleys (BLM 2008b, UDWR 2009b). Depending on the season, weather, and nutritional requirements, this species occupies different habitat types during the year. Important areas for sage-grouse are the leks, brood rearing areas, and wintering areas. Leks may be located between summer and winter ranges, or, in some cases, summer and winter ranges may be the same (Call and Maser 1985). Preferred nesting habitat occurs up to a 5-mile radius from the leks (Connelly et al. 2000).

Nesting habitats consist of shallow depressions lined with grass or twigs, and are usually located under sagebrush. The principal sage-grouse winter food is sagebrush leaves. During the summer, greater sage-grouse feed on the leaves and fruiting heads of sagebrush; the flower heads of clovers, dandelions, grasses, and other plants; and various insects (Kaufman 1996, UDWR 2002). Greater sage-grouse feed almost exclusively on sagebrush in the winter (Connelly et al. 2000, Patterson 1952), and therefore, are mostly restricted to sagebrush habitats during that season. Because sage-grouse need to access sagebrush, winter habitat tends to exist on south- to west-facing slopes that are less than 10 percent slope and are generally located in windswept areas (Beck 1977, Crawford et al. 2004), where the height of sagebrush exceeds the depth of snow.

The BLM Washington Office IMs No. 2012-043 and 2012-044 (BLM 2011b, 2011c) supplement the BLM's 2004 National Strategy for sage-grouse and identify those management actions necessary to sustain sage-grouse populations, while achieving the DOI's energy-related priorities. The UDWR has not yet identified priority habitat using a consistent methodology. A priority habitat designation is the highest conservation value that can be given relative to maintaining suitable sage-grouse populations range-wide. The Governor's task force finalized the Conservation Plan for Greater Sage Grouse in Utah in February 2013. The Plan identifies Preliminary Priority Habitat (PPH) and the Preliminary General Habitat for sage-grouse in accordance with IM 2012-044. Neither of these habitats are mapped within the MBPA. No habitats designated as occupied, brood rearing, or winter habitats for sage-grouse occur within the MBPA. However, an historic sage-grouse lek is located in the MBPA. The lek is known as the Myton Bench – Wells Draw lek and was last reported active in 1999, with six males in attendance (BLM 2009b).

Impacts

Oil and gas development can cause sage-grouse populations to decline; however, the specific reasons for declines are still unknown (Braun et al. 2002; Connelly et al. 2000). The primary impacts of development to sage-grouse include direct habitat loss from well pad, road, pipeline and facility construction, as well as avoidance and displacement due to increased human activity and habitat fragmentation. Braun et al. (2002) maintain that oil and gas development may have negative short-term (site construction, drilling, and completion), and long-term (road development) effects.

Numerous citations have linked oil and gas development to declines in sage-grouse populations. For example, Holloran (2005), Doherty et al. (2008), Walker et al. (2007), Lyon and Anderson (2003), and Crompton and Mitchell (2005) have linked population reductions in response to oil and gas development. Sage-grouse exhibit fidelity to traditional winter use areas, and surface disturbance and human activity in these areas may cause sage-grouse to displace to less suitable adjacent habitats, which may not have the desired vegetative cover and/or may leave the species more susceptible to predation.

Additionally, various studies have determined that sage-grouse are affected by human activity (Braun 1986; Lyon and Anderson 2003; Remington and Braun 1991). These studies have determined that hens nested farther away from leks in areas where human disturbance occurred, and that nesting initiation rates were also lower. In addition, it was also determined that male attendance at leks was lower when human activity occurred within 2 miles. The UDWR identified one lek, known as the Myton Bench – Wells Draw lek, near the southwestern portion of the MBPA, approximately 0.5 miles from the nearest proposed development. This lek was last reported as active during the 1999 season, and has since been eliminated and replaced by project facilities. Therefore, there would be no impacts to leks within the MBPA from implementation of Alternative D.

The UDWR has not yet identified priority habitat with a consistent methodology. Although most of the habitat within the MBPA is marginal for sage-grouse breeding and nesting, it is possible that a few individual sage-grouse occasionally use portions of the MBPA. Approximately 2,185 acres of sagebrush shrubland, which may provide marginal habitat for sage-grouse, would be disturbed from activities related to Alternative D. While it is likely that some sage-grouse use portions of the MBPA on a limited basis, there is no PPH for sage-grouse within the MBPA. The nearest PPH is located approximately 0.6 mile south of the MBPA. Additionally, there are no habitats designated as occupied, brood rearing, or winter habitats for sage-grouse within the MBPA. Project-related noise (e.g., increased volumes or types of noise from construction, drilling, and production equipment, changes in ambient tones or tonal noises, and repetitive low frequency noise emanating from production equipment such as compressor stations) may affect sage-grouse that occasionally occupy the MBPA. Sage-grouse could be temporarily displaced by noise and other human activities until activities are completed.

Determination for Greater Sage-grouse

Based on the information above, implementation of Alternative D may impact individual sage-grouse, but ***is not likely to result in a trend towards federal listing of the species.***

Conclusion

If you have any questions or need additional information, please contact Dan Emmett, Wildlife Biologist at (435) 781-3414, Christine Cimiluca, Botanist at (435) 781-4454, or Stephanie Howard, Environmental Coordinator at (435) 781-4469.

Enclosure(s): Biological Assessment for Newfield Exploration Corporation Monument Butte Oil and Gas Development Project in Uintah and Duchesne Counties, Utah

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Biological Assessment for Newfield Exploration Corporation Monument Butte Oil and Gas Development Project in Uintah and Duchesne Counties, Utah

UT-G010-2009-0217

Bureau of Land Management
Vernal Field Office

Location: **Township 4 South, Range 1 East**
Township 4 South, Range 1-3 West
Township 5 South, Range 1 and 2 East
Township 5 South, Range 3 West UBM
Township 8 South, Range 15-19 East
Township 9 South, Range 15-19 East
Township 10 South, Range 15-18 East SLBM
Duchesne and Uintah Counties, Utah

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April 2015

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1.0 INTRODUCTION AND BACKGROUND

1.1 SECTION 7 PROCESS

Under provisions of the federal Endangered Species Act (ESA) (16 United States Code Section 1531 et seq.), federal agencies are directed to conserve threatened and endangered species and the habitats in which these species are found. Federal agencies are also required to ensure actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of endangered and threatened species or their critical habitat. The ESA requires action agencies, such as the Bureau of Land Management (BLM), to consult or confer with the United States (U.S.) Fish and Wildlife Service (USFWS) and/or national Marine Fisheries Service (NMFS) when there is discretionary federal involvement or control over the action. Formal consultation becomes necessary when the action agency requests consultation after determining the proposed Alternative is likely to adversely affect listed species or critical habitat, or the aforementioned federal agencies do not concur with the action agency's finding (USFWS 1998). A Biological Assessment (BA) is required under Section 7(c) of the ESA, if listed species or their critical habitat may be present in the area affected by any of the major construction and development activities.

Under the 1994 Memorandum of Understanding (MOU) and the 2000 Memorandum of Agreement (MOA) among the BLM, U.S. Forest Service (USFS), USFWS, and NMFS, all four agencies agreed to promote the conservation of candidate and proposed species and streamline the Section 7 consultation and coordination process.

This BA provides documentation for the Agency Preferred Alternative (Alternative D) to meet federal requirements and agreements set forth among the federal agencies listed above. It addresses federally listed threatened and endangered, candidate and proposed species and has been prepared under the 1973 ESA Section 7 regulations, in accordance with the 1998 procedures set forth by USFWS and NMFS, and in accordance with the 1994 and 200 MOU and MOA, respectively. It is being prepared to initiate consultation for the Agency Preferred Alternative (Alternative D) of the Environmental Impact Statement (EIS) for the Newfield Exploration Corporation (Newfield) Monument Butte oil and gas development project. The BLM requests USFWS concurrence with the determinations made in this BA.

1.2 PROJECT BACKGROUND

Newfield Exploration Company (Newfield) has notified the United States (U.S.) Bureau of Land Management's (BLM) Vernal Field Office (VFO) of its need to expand their ongoing oil and natural gas development within and in the vicinity of the Greater Monument Butte Unit (GMBU). Newfield proposes to implement a plan to fulfill its obligations and responsibilities under federal leases to explore, develop, and produce commercial quantities of oil and natural gas. The Monument Butte Project Area (MBPA) is located in southeastern Duchesne County and southwestern Uintah County. The MBPA consists of approximately 119,743 acres located in Township 4 South, Range 1 East; Township 5 South, Range 3 West; Township 8 South, Range 15-19 East; Township 9 South, Range 15-19 East; and Township 10 South, Range 15-18 East (see **Figure 1.1-1 – Attachment 1**).

Surface ownership in the MBPA is approximately 87 percent federal (managed by the BLM), approximately 11 percent State of Utah (managed by State Institutional Trust Lands Administration [SITLA]), and approximately 2 percent private. Mineral interests are owned by the BLM (89 percent), the State of Utah (10 percent), and private interests (less than one percent). Lands with separate surface and mineral ownership, also known as "split estate lands," comprise approximately 18 percent of land within the MBPA. Mineral and surface ownership rights are summarized in **Table 1.2-1**.

TABLE 1.2-1
SURFACE AND OIL AND GAS MINERALS OWNERSHIP WITHIN THE MBPA

Surface Owner	Surface Acres	Surface Percentage	Mineral Acres	Mineral Percentage
BLM	103,891	87	106,562	89
State of Utah	12,878	11	11,983	10
Private	2,974	2	1,198	1
Totals	119,743	100	119,743	100

Federal lands in the MBPA are under the jurisdiction of the BLM VFO. The VFO has determined that implementing the proposed development constitutes a federal action requiring the preparation of an Environmental Impact Statement (EIS). The EIS serves the purpose of disclosing and analyzing impacts from the Proposed Action, the No Action alternative, and the other alternatives that have been developed.

Newfield's objective is to develop their leases and efficiently produce commercial and economic quantities of oil and gas in the MBPA. Newfield estimates that its plan could yield over 334.9 million barrels of oil (MMBO), 540,669 million cubic feet (MMCF) of natural gas, and 10,085 million barrels (Mbbl) of natural gas liquids (NGLs) from the Green River formation, and 6.9 trillion cubic feet (Tcf) of natural gas from the deep gas development through 2035.

1.2.1 Existing Disturbance

As previously stated, the MBPA is an existing oil and gas field with substantial existing and ongoing oil and gas development. As of October 2014, there are approximately 3,725 acres of existing disturbance from well pads, access roads, pipeline and utility corridors, other oil and gas infrastructure, and livestock improvements. As of October 2014, according to the Utah Division of Oil and Gas Mining's database, oil and gas infrastructure within the MBPA consists of approximately 3,209 wells. A breakdown of existing well types within the MBPA is included in **Table 1.2.1-1**.

TABLE 1.2.1-1
EXISTING WELLS WITHIN THE MBPA

Existing Wells within the MBPA	
Well Type	**Number**
New Permit	2
Approved Permit	264
Drilling	41
Producing	1,290
Shut-in	135
Temporarily-abandoned	16
Plugged & Abandoned	41
Active	1,222
Inactive	1
Location Abandoned	189
Drilling Operations Suspended	8
TOTAL	**3,209**

There are approximately 634 miles of existing road within the MBPA, consisting of a combination of paved and/or improved roads, unimproved roads, and two-tracks. Miles of existing pipeline corridor are difficult to calculate, given that numerous miles have been buried and the surface reclaimed, and that surface-laid pipelines are difficult to see on aerial imagery. However, the miles of existing pipeline are probably similar to or greater than the miles of existing roads. Other existing infrastructure within the MBPA includes:

- One electrical sub-station/generation station;
- Nine injection facilities;
- One gas and oil separation plant;
- Two gas processing plants;
- One water supply well; and
- Three compressor stations

Newfield is the primary operator within the MBPA; however, there are numerous lease owners within the unit.

1.3 CONFORMANCE WITH BLM MANAGEMENT PLANS AND OTHER LAWS AND POLICY CONSIDERATIONS

Management objectives for lands under the authority of the VFO are contained within the Vernal ROD and approved Resource Management Plan (RMP) (BLM 2008b). The RMP allows for the exploration and development of oil and gas resources while protecting or mitigating impacts to other resource values.

The goals and objectives of the Minerals and Energy Resources management decisions of the Approved RMP are as follows:

- "Meet local and national non-renewable and renewable energy and other public mineral needs.
- Support a viable long-term mineral industry related to energy development while providing reasonable and necessary protections to other resource.
- The following principles will be applied:
    - Encourage and facilitate the development by private industry of public land mineral resources in a manner that satisfies national and local needs and provides for economical and environmentally sound exploration, extraction and reclamation practices.
    - Process applications, permits, operating plans, mineral exchanges, leases, and other use authorizations for public lands in accordance with policy and guidance.
    - Monitor salable and leasable mineral operations to ensure proper resource recovery and evaluation, production verification, diligence, and inspection and enforcement of contract sales, common use areas, community pits, free use permits, leases and prospecting permits.
- This plan will recognize and be consistent with the National Energy Policy by:
    - Recognizing the need for diversity in obtaining energy supplies
    - Conserving sensitive resource values
    - Improving energy distribution opportunities" (BLM 2008b).

Most of the subject leases were issued prior to the completion of the Vernal ROD and Approved RMP, and with stipulations that were standard at that time. Development conducted under these leases that were issued prior to the approval date of the Vernal ROD and Approved RMP are not subject to conformance with the Approved RMP if conformance would conflict with valid existing rights afforded by the leases. For those leases issued after the approval date, the management decisions of the Approved RMP would apply.

In addition, some plans proposed in the Approved RMP, such as the comprehensive integrated activity plan described in the ACEC-11 decision, had not been finalized at the time Alternative D was analyzed (BLM 2008b).

Alternative D is deemed in conformance with management decisions made in the Vernal ROD and Approved RMP where applicable.

1.3.1 Consistency with Other Plans, Statutes, and Objectives

Utah Code Section 63J-8-105.5 established the Uintah Basin Energy Zone, which includes the MBPA. The highest management priority for these lands is responsible development of energy resources. SITLA has leased all of the state lands within the MBPA and permits on-going oil and gas production. These actions are consistent with SITLA's primary objective to fund the state school system. Alternative D would allow for oil and gas production on federal leases and would be consistent with the objectives of the Uintah Basin Energy Zone.

Alternative D would be in compliance with the *Duchesne County General Plan*, as amended (Duchesne County 2005, 2007, 2012, 2013). This General Plan supports responsible natural resource use and development and emphasizes the need to keep public lands open for oil and gas exploration and development under multiple-use and sustained yield principles.

Alternative D would be in compliance with the *Uintah County General Plan 2005*, as amended (Uintah County 2005, 2012). This General Plan supports oil and gas development, emphasizes responsible multiple-use of public lands, and optimizes utilization of public resources.

Alternative D would be in compliance with Federal, State, and local laws and regulations. Increased development of oil and gas resources on public lands is consistent with Federal Onshore Oil and Gas Leasing Reform Act of 1987 (FOOGLRA), Comprehensive National Energy Strategy announced by the U.S. Department of Energy in April 2008, the Energy Policy and Conservation Act (42 U.S.C. 6201), and the Energy Policy Act of 2005.

1.4 SPECIES CONSIDERED IN THE ANALYSIS

In order to address potential impacts to federally listed species, the USFWS special status species lists for Uintah and Duchesne counties (USFWS 2015) were reviewed.

Four endangered species and four threatened species were identified as potentially occurring within the MBPA (**Table 1.4-1**). In addition, designated critical habitat for the four endangered Colorado River fish species was identified for analysis.

In total, eight species were analyzed in Chapter 3.0 of this BA based on potential or known occurrence within the MBPA. Six of these species potentially occur within the MBPA (western yellow-billed cuckoo, Colorado pikeminnow, razorback sucker, Uinta Basin hookless cactus, Pariette cactus, and Ute ladies'tresses). The other two species (bonytail and humpback chub) were included in the analysis due to potential water depletion impacts within the Colorado River basin downstream of the MBPA.

TABLE 1.4-1 THREATENED AND ENDANGERED SPECIES CONSIDERED IN THIS ANALYSIS

Common Name	Scientific Name	Status	Species Excluded from Further Analysis	Reason for Exclusion
Mammals				
Canada lynx	*Lynx canadensis*	Threatened	Yes	Potential habitat for this species does not occur in the MBPA.
Black-footed ferret	*Mustela nigripes*	Endangered	Yes	Potential habitat for this species does not occur in the MBPA.
Birds				
Yellow-billed Cuckoo	*Coccyzus americanus*	Threatened	No	
Greater sage-grouse	*Centrocercus urophasianus*	Candidate	No	
Mexican spotted owl	*Strix occidentalis lucida*	Threatened	Yes	Potential habitat for this species does not occur in the MBPA.
Fish				
Colorado pikeminnow	*Ptychocheilus lucius*	Endangered	No	
Bonytail chub	*Gila elegans*	Endangered	No	
Humpback chub	*Gila cypha*	Endangered	No	
Razorback sucker	*Xyrauchen texanus*	Endangered	No	
Plants				
Clay reed-mustard	*Schoenocrambe argillacea*	Threatened	Yes	Potential habitat for this species does not occur in the MBPA.
Shrubby reed-mustard	*Schoenocrambe suffrutescens*	Endangered	Yes	Potential habitat for this species does not occur in

TABLE 1.4-1 THREATENED AND ENDANGERED SPECIES CONSIDERED IN THIS ANALYSIS

Common Name	Scientific Name	Status	Species Excluded from Further Analysis	Reason for Exclusion
				the MBPA.
Barneby ridge-cress	*Lepidium barnebyanum*	Endangered	Yes	Potential habitat for this species does not occur in the MBPA.
Ute ladies'-tresses	*Spiranthes diluvialis*	Threatened	No	
Pariette cactus	*Sclerocactus brevispinus*	Threatened	No	
Uinta Basin hookless cactus	*Sclerocactus wetlandicus*	Threatened	No	

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2.0 AGENCY PREFERRED ALTERNATIVE (ALTERNATIVE D)

In accordance with CEQ regulations, the BLM is required to identify a preferred alternative in the EIS if one or more exists. Alternative D, the Resource Protection Alternative, is the Agency Preferred Alternative. Alternative D was developed to respond to issues raised during scoping about reducing potential impacts to sensitive resource and land uses. The parameters of this alternative were adjusted between the Draft EIS and the Final EIS in response to technical issues raised during the public comment period, which were not considered when the alternative was originally being designed. The data provided during the comment period regarding these technical issues was reviewed by BLM engineers and was determined to be largely accurate. The impact of these technical issues to the proponent's ability to diligently and efficiently develop oil and gas resources in the Project Area as required by regulation and the terms of their leases was significant. Therefore, the BLM determined adjustments to the agency preferred alternative were necessary and in conformance with the purpose and need for this EIS. The alternative adjustments are all contained within the range of alternatives considered in the Draft EIS, so it was determined that a Supplement to the Draft EIS was not necessary.

For the MBPA, the primary objective of the Resource Protection Alternative is to meet the purpose and need for the Project while 1) protecting the relevant and important values of the Pariette Wetlands Area of Critical Environmental Concern (ACEC); 2) minimizing the amount of new surface disturbance and habitat fragmentation within and around USFWS proposed Level 1 and 2 Core Conservation Areas (for two federally-listed plant species: the Uinta Basin hookless cactus [*Sclerocactus wetlandicus*] and the Pariette cactus [*Sclerocactus brevispinus*]); 3) precluding new well pads (with the exception of Newfield's proposed water collector well) and minimizing new surface disturbance (roads or pipelines) within 100-year floodplains; 4) precluding new well pads, pipelines, or roads within riparian habitats; and 5) minimizing overall impacts from the proposed oil and gas development through the use of directional drilling technology. **Figure 2-4 (Attachment 1)** depicts the location of the ACEC and Core Conservation Areas in the MBPA. **Figure 3.6.3.2-1 (Attachment 1)** depicts the location of the 100-year floodplains in the MBPA.

Advancements in directional drilling technology have increased the maximum vertical section displacement for the shallow Green River Formation to distances of 800 to 1,200 feet though significant technical and economic challenges are encountered in those wells (increased equipment wear and tear resulting in more frequent workover or replacement cycles and associated increased costs, and reduction in areal waterflood sweep).

2.1 DESCRIPTION OF ALTERNATIVE D

2.1.1 Pariette Wetlands ACEC

Under Alternative D, the areas where the ACEC relevant and important values (special status bird and plant habitat, wetlands ecosystem) occur would be protected as described in **Sections 2.11.1 100-Year Floodplains, Riparian Areas, and other Water Resources**, **2.1.1.2 Special Status Species**, and **2.1.2 Cactus Core Conservation Areas**. In the remainder of the ACEC, new or expanded well pads could be built following the low density development guidance described in **Section 2.1.3** and subject to the restrictions described below, so long as surface disturbance is minimized to the extent possible and no impacts occur to the relevant and important values. In those cases, site-specific NEPA assessments would be completed to facilitate avoidance of impacts to relevant and important values.

2.1.1.1 100-Year Floodplains, Riparian Areas, and other Water Resources

Under Alternative D:

- No surface disturbance would occur within 500 feet of Pariette Creek or Pariette ponds.

- No new well pad-related surface-disturbing activities would be allowed within active floodplains, public water reserves, or 100 meters of riparian areas.

- No new pipeline- or road-related surface-disturbing activities would be allowed within active floodplains, public water reserves, or 100 meters of riparian areas, unless there are no practical alternatives or the action is designed to enhance the riparian resources. Unavoidable impacts would be fully mitigated.

- For all tributaries that drain directly to Pariette Draw or directly to the Green River, roads and well pads would be set back a minimum of 200 feet from the active stream channel (average 3 feet wide or greater without an associated riparian zone) unless site-specific analysis demonstrates that:
  - 1) the proposed well or road could be placed on higher terrain above the 100-year floodplain,
  - 2) the 100-year floodplain can be demonstrated to be narrower than 200 feet in the area proposed for well location; or
  - 3) the well pad or road can be increased in height to avoid a predicted over-topping 50-year flood.
    - In these situations, the well pad or road would not be placed closer than 100 feet from the stream channel.

- Pipelines that cross or are within 100-year floodplains will either be elevated above the predicted 100-year flood event on a pipe bridge, or buried at least 5 feet below the channel bottom or below the predicted scour depth for an equivalent flood event (whichever is deeper) and in conformance with hydrological design practices.

- Pipelines that cross stream channels will incorporate a sediment retention system along the construction corridor to minimize movement of sediment into the water courses. These could range from silt fencing and culverts to sediment retention basins, depending on the location.

- Newfield will utilize the applicable USFWS BMPs for work in Utah streams where pipelines or roads cross a stream.

- Newfield will utilize BLM Hydraulic Considerations for Pipeline Crossings of Stream Channels (prepared by the Utah State Office BLM, Salt Lake City, Utah).

- Road crossings of drainages will be built to accommodate the 100-year flood, typically using at-grade crossings rather than culverts. Crossings will be designed so they will not cause siltation or accumulation of debris, nor will the roadbed block the drainage. Any culverts used will be designed and constructed to allow passage of aquatic species.

- As determined necessary on a site-specific basis (based on proximity to a 100-year floodplain), wells with the potential to contaminate surface waters will have automatic shutoff valves.
- Any pipeline conveying produced water or other industrial liquid across the 100-year floodplains as conceptually depicted in FEIS **Figure 3.6.3.2-1** would be provided with shut-off valves immediately outside the 100-year floodplain on both sides of the crossing.

- Storage and parking locations for hazardous materials, lubricants, fuel tanks or trucks, and refueling activities would be a minimum distance of 100 meters from wetlands, riparian areas, and channels with defined bed and banks. Such materials storage or refueling activities would be outside the 100-year floodplains as depicted in FEIS **Figure 3.6.2.3-1**.

- Flow monitors would be installed on produced water pipelines to detect possible leaks. If any of the following impacts are observed, the adaptive management mitigation identified in the long term water monitoring plan (see **Attachment E**) will be implemented:
    - increased sedimentation;
    - increased concentrations of inorganic constituents, including metals;
    - increased concentrations of selenium, boron, or total dissolved solids;
    - contamination with petroleum and other organic constituents;
    - reduction of spring flows; and/or,
    - reduction of water levels in wells.

2.1.1.2 Special Status Species

In addition to the fish and wildlife ACEPMs listed in **Section 2.3.14**, and the guidance for development in *Sclerocactus* Core Conservation Areas (**Section 2.1.2**) the following measures would be implemented under Alternative D:

- The Conservation, Restoration, and Mitigation Strategy for the Pariette and Uinta Basin Hookless Cactus for the Newfield Greater Monument Butte Project (**Attachment F**) developed by FWS and Newfield will be implemented under this Alternative.
-
- Additional *Sclerocactus* Design Features:

    - Surveys will be completed by a qualified botanist in potential *Sclerocactus* habitat prior to BLM's consideration of any surface disturbing activities, in accordance with the latest conservation measures and FWS protocols and Memorandums of Understanding.

    - BLM's priority will be to locate any new surface disturbance more than 300 feet from *Sclerocactus* populations or individuals, except for surface pipelines, which is 50 feet.

    - When the edge of surface disturbance (surface disturbance for this document is defined as a buried pipeline adjacent to an existing road or a well pad expansion[1]) is located within 300 feet of populations or individuals of *Sclerocactus*, the following actions will be taken to minimize the impacts:

[1] In limited cases as defined in the FWS/Newfield Conservation, Restoration, and Mitigation Strategy for the Pariette and Uinta Basin Hookless Cactus (**Attachment F**) it may be possible to install a new well pad and road within 300 feet of cactus.

- Pad expansion construction or pipeline installation work would occur outside the flowering period (March 15 to June 30).

- All disturbed areas will be revegetated with native species comprised of species indigenous to the area and non-native species that are not likely to invade other areas.

- Erosion control methods (e.g., silt fencing) will be used to protect cacti that are within 300 feet and down slope or downwind of surface disturbance and should only be implemented within the area proposed for surface disturbance. Fencing is intended to prevent sedimentation or dust deposition and will be evaluated for effectiveness by a qualified botanist.

- A qualified botanist will be on site to monitor surface-disturbing activities when cacti are within 300 feet of any surface disturbance.

- Dust abatement will occur over the life of the project on disturbed surfaces in suitable habitat where plants are closer than 300 feet to surface disturbing activities, during the time of year when the species is most vulnerable to dust-related impacts (March to August). Abatement will be designed to minimize potential for dust plume generation and will use water only.

- Cacti within 300 feet of a proposed surface disturbance will be flagged immediately prior to surface-disturbing activities, and flags will be removed immediately after surface-disturbing activities are completed. Leaving cacti flagged for as short a time as possible will minimize drawing attention to the cacti and reduce the potential for theft.

- New pipelines will be sited to maximize the distance from adjacent *Sclerocactus wetlandicus, S. brevispinus*, and hybrids.

- Surface pipelines placed closer than 50 feet of individuals or populations will be secured to prevent pipeline movement.

- Project personnel associated with construction activities will be instructed to drive at a speed limit of 15 miles per hour on unpaved roads and to remain on the existing roads and ROWs at all times.

- Noxious weeds may be controlled with herbicides in accordance with BLM policy. However, weed control methods within 50 feet of individuals and populations would include provisions for mechanical removal, as opposed to chemical.

- A monetary amount, as calculated by the USFWS, will be contributed to the *Sclerocactus* Mitigation Fund to aid in the recovery of *Sclerocactus* species impacted by the project.

- Native plants will be seeded according to BLM's reclamation guidelines.

- All crews will be informed of potential *Sclerocactus* presence, identification, and legal repercussions associated with "take' of a listed species.
- If a spill occurs within the *Sclerocactus* T&E potential, critical, or core habitats polygon, Newfield would provide a copy of the official spill report to USFWS within the same timeframe required by the regulatory agency.
- Initial pre-disturbance 100% clearance surveys will be conducted following standard methodology and will be valid for a period of 4 years.
    - If more than 4 years pass between the original surveys and construction, a new 100% clearance survey will be required.
    - If construction is to occur within the 4 year window, an additional, reduced-effort "spot check" survey will be conducted following the below methodology in the year of project construction.

2.1.2 Cactus Core Conservation Areas[i]

Under Alternative D, the following measures, based on USFWS' management guidelines and recommended protection of Core Conservation Areas (see **FEIS Appendix I**), would be implemented to minimize the effects of energy development on *Sclerocactus* habitat. Two levels of core conservation areas would be used to manage development in relation to cactus core habitat (see **Figure 2-4 - Attachment 1**). The following definitions are pertinent to this portion of Alternative D:

- Actions that occur entirely within previously disturbed areas (such as reopening reserve pits so long as the spoils do not disperse onto adjacent undisturbed areas or burying pipelines in existing roads), are not considered "new" surface disturbance.
- Temporary use areas (areas that are outside of the current edge of disturbance, i.e. outside reclaimed reserve pits, that would be used to erect and disassemble the drilling derrick) are considered "new" surface disturbance.
- BLM designated plugged and abandoned wells (P&A) for purposes of this EIS are considered by the BLM to be fully reclaimed but are given preference for construction of new well pads over previously undisturbed areas.
    - A well that is BLM P&A status has had a Final Abandonment Notice (FAN) submitted by the company, and accepted by the BLM (this definition differs from the P&A definition for the State of Utah, which defines P&A as the well is plugged but the location is not reclaimed). The acceptance of a FAN by the BLM documents the compliance of the company with the BLM's then-in-force reclamation standards and the release of the company from obligation regarding future problems with the well (release of the bond). If problems with the reclamation of a P&A well are identified by the BLM after the FAN is accepted, then the BLM is responsible for any remedial actions.

2.1.2.1 Level 1 Core Conservation Areas

In Level 1 areas, which are 400-meter buffer zones around high plant density populations, surface disturbance would be avoided to the greatest extent practicable by using existing infrastructure (i.e., access roads and pipelines) and directional drilling from multi-well pads. In addition, the following conditions would apply:

- New wells could be directionally drilled from existing well pads, and new pipelines could be installed in existing roads so long as no new surface disturbance is required.

- No new well pads would be allowed, except as allowed under the FWS/Newfield Conservation, Restoration, and Mitigation Strategy for the Pariette and Uinta Basin Hookless Cactus (**Attachment F**). In limited cases, well pad expansions could occur and new pipelines could be installed directly adjacent to existing roads so long as new surface disturbance is minimized, use of existing disturbance is maximized, the appropriate mitigation from **Section 2.1.1.2** is applied, and a monetary amount (determined by the USFWS) is contributed to the *Sclerocactus* mitigation fund.

One of the goals of Alternative D is to prevent new surface disturbance within Level 1 Core Conservation Areas. However, site-specific conditions may necessitate the creation or expansion of well pads to facilitate the waterflood program to fully recover the mineral resource. In those cases, site-specific NEPA assessments would be completed, reinitiation of consultation would occur as needed, and site-specific mitigation measures would be applied.

2.1.2.2 Level 2 Core Conservation Areas

In Level 2 areas, which are 1,000-meter buffer zones around but not including the Level 1 areas, surface disturbance would be minimized to the greatest extent practicable by using existing infrastructure (i.e., access roads and pipelines) and directional drilling from multi-well pads. Under Alternative D there would effectively be two possible drilling scenarios in Level 2 Core Conservation Areas, with Scenario 1 being BLM's preferred choice:

- Scenario 1) New wells could be directionally drilled from existing well pads, and new pipelines could be installed in existing roads so long as no new surface disturbance is required.

- Scenario 2) New surface disturbance would be allowed as described below, so long as new and existing surface disturbance would not exceed the 5% disturbance cap recommended in the Draft Management Guidelines for the Core Conservation Areas (see **FEIS Appendix I**) except as allowed under the FWS/Newfield Conservation, Restoration, and Mitigation Strategy for the Pariette and Uinta Basin Hookless Cactus (**Attachment F**).
    - New well pads would be allowed in areas where the mineral resource can't be reached from existing pads or to accommodate deep gas drilling; and

    - Well pad expansions to accommodate additional wells, and buried pipeline installation directly adjacent to existing roads to accommodate conversion of existing producing wells to injection, would be permitted so long as the new surface disturbance is minimized, use of existing disturbance is maximized, and the appropriate mitigation from **Section 2.1.1.2** is applied.

  - In sections where existing well pads exceed four pads per section, no new well pads would be allowed, unless reclamation of current pads occurs so that the total existing plus new well pad count is four per section.

- Well pad expansions to accommodate additional wells, and buried pipeline installation directly adjacent to existing roads to accommodate conversion of existing producing wells to injection, would be permitted so long as the new surface disturbance is minimized, and the appropriate mitigation from **Section 2.1.1.2** is applied.

2.1.3 New Development Based on Existing Well Density (In Areas Outside ACEC and CCAs)

An additional goal of Alternative D is to reduce the amount of surface disturbance from the proposed project in areas outside the Pariette Wetlands ACEC and Core Conservation Areas by reducing the size of new wells pads[2], reclaiming areas of existing disturbance, and increasing the use of multi-well pads. Therefore, under this alternative, numerous existing single-well pads would be converted to a complex of multi-well, directional drilling pads and waterflood injection wells, which would have a lower overall disturbance.
Figure 2.6-1 (Attachment 1) shows the existing high- and low-density development areas within the MBPA. High-density development areas are those areas that already have from six to 16 well pads per 640-acre section (i.e., one well pad per 40 to 106 acres). Low-density development areas are defined as those areas that have had no development at all or contain up to five well pads per section.

Of the 197 sections or portions of sections within the MBPA, 115 (about 58 percent) are within high-density development areas. Average existing surface disturbance within the high-density development areas is 39.0 acres per section, and the average number of existing well pads per section is 14.3. Approximately 82 sections or portions of sections occur within the low-density development areas. The average existing disturbance within the low-density development areas is 11.9 acres per section, and the average number of existing well pads per section is 2.8.

Within high-density development areas, four large, existing well pads per section could be expanded by about 0.2 to 0.8 acres per new well (anticipated to be up to six wells per existing pad, consisting of one existing vertical 40-ac oil/injection one new directional 20-ac oil one new vertical deep gas; and three new directional deep gas). Additionally, within high-density development areas, 12 small well pads per section could be expanded by about 0.2 acres per well to accommodate one new directional 20-ac oil well (i.e., each existing well pad is anticipated to contain up to two wells, consisting of one existing vertical 40-ac oil/injection and one new directional 20-ac oil). Based on GIS calculations of the conceptual number of locations available for construction and drilling in the Project Area using the design parameters discussed above, locations for new wells are available in excess of the number of wells proposed to be drilled under Alternative D.

For analysis purposes, it is assumed that existing well pads would be reclaimed back to be a minimum of 1 acre per pad. Under this scenario, the existing pads, with an average size of 2 acres each (or 24 acres total), would be reclaimed down to approximately 1 acre each, which is the average area of disturbance

[2] The DEIS agency preferred alternative focused on reducing the number of new well pads. Based on public comment on technical limitations of waterflood operations, the focus of the EIS has shifted to reduce the size of well pads in high and low density areas. However, under the revised agency preferred alternative the anticipated number of well pads is still substantially lower than those expected under the Proposed Action.

needed to accommodate safe operation of a workover rig and crew when well maintenance or re-completion on the waterflood injection well is required. Therefore, an average of 1 acre would be reclaimed for each existing well pad. This equates to 16 acres per section (for 16 wells), which would result in a substantial decrease in the residual or long-term amount of surface disturbance within the MBPA.

For low-density development areas with zero to five existing well pads per section, the proposed surface density would be no more than four large, new well pads per 640-acre section (i.e., one large well pad per 160 acres) and twelve small, new well pads per 640-acre section (i.e., three small well pads per 160 acres). See **Figure 2.6-2B (Attachment 1)** for a graphical representation. There would be no restriction on the number of wells that could be drilled from those well pads, provided that the wells conform to UDOGM downhole spacing requirements, which is currently 20 acres. For purposes of impact analysis, it is assumed that the large well pads would each accommodate one vertical deep gas well, three directional deep gas wells, one vertical 40-acre oil well which would then be converted to an injection well after about two years of production, and one directional 20-acre oil well. It is also assumed that the twelve small well pads would each accommodate one 40-acre vertical oil well which would then be converted to an injection well, and one 20-acre directional oil well. Based on GIS calculations of the conceptual number of locations available for construction and drilling in the project area using the design parameters discussed above, locations for new wells are available in excess of the number of wells proposed to be drilled under Alternative D. However, for purposes of impact analysis, it is assumed that total well counts for oil and gas wells would not exceed that evaluated under Alternative D. For analysis purposes it is assumed that new well pads would be reclaimed back to a minimum of 1 acre per pad for production.

Under Alternative D, approximately 5,750 oil and gas wells would be developed on BLM, State, and private lands in the MBPA from up to 1,245 new well pads and 1,538 existing well pads. Newfield would drill associated wells at an average rate of 360 wells per year. Under this drilling scenario, construction, drilling, and completion of all 5,750 wells would occur for approximately 16 years. The total number of wells drilled would depend largely on outside factors such as production success, engineering technology, reservoir characteristics, economic factors, commodity prices, rig availability, and lease stipulations. The anticipated life of an individual well is 20 to 30 years, and the anticipated time it would take for field abandonment and final reclamation is 5 years. Therefore, the anticipated LOP under Alternative D would be 41 to 51 years. Conceptual locations for the proposed well pads and other surface facilities are illustrated on **Figure 2-4 (Attachment 1)**.

Alternative D includes the following primary components (see **Figure 2-4 – Attachment 1**):

- Development of approximately 750 new Green River vertical oil wells to be drilled from a combination of new, small and large well pads, all of which would eventually be converted into waterflood injection wells;

- Development of approximately 2,500 new deep gas wells that would be vertically or directionally drilled from a combination of new and existing, large well pads;

- Development of approximately 2,500 new 20-acre downhole spacing Green River oil production wells to be directionally drilled from a combination of new or existing, small and large well pads.

- Construction of approximately 226 miles of new 100-foot-wide ROW that would be used for new road construction (40-foot width) and pipeline installation (60-foot width). Up to 70-foot-wide expansion along approximately 318 miles of existing access road ROW that would be used for road upgrade (10-foot width) and pipeline installation (60-foot width);

- Construction of 20 new compressor stations for deep gas well development;
- Expansion of three existing Green River oil well compressor stations and construction of one new compressor station for gas associated with Green River oil well development;
- Construction of up to one 50-MMscf/d centralized Green River oil well gas processing plant;
- Construction of up to 13 gas driven water treatment and injection facilities for management and distribution and injection of produced water;
- Construction of up to 12 GOSPs for oil and produced water collection;
- Development of one fresh water collector well for waterflood operations; and
- Construction of six water pump stations.

Surface disturbance anticipated under Alternative D is shown in **Table 2.1.3-1**. Initial surface disturbance would occur during and after the construction, drilling, completion, and testing activities. Prior to interim reclamation, initial surface disturbance for well pads, access roads, pipeline ROWs, and other surface facilities would equal approximately 10,122 acres. Those portions of the well pads, access road ROWs, pipeline ROWs, and other facilities not needed for production operations would be reclaimed within two to three growing seasons, assuming optimal conditions are present. The remaining surface disturbance would be residual or "long-term" disturbance of approximately 4,978 acres during the LOP.

[i] After BLM review of the terms of the BLM leases and the Monument Butte Unit Agreement, it has been determined that of the ten BLM leases that intersect Core areas and do not have wells drilled on them (see Figure 6), eight are committed to the Greater Monument Butte Unit and are held by Unit production, and the other two, although not committed to the Unit, are already subject to No Surface Occupancy stipulations in their lease terms.

The question was asked whether surface disturbance restrictions in Core Areas would result in the leases not being developed and as a result being dropped from the Unit, which would adversely affect lease interest owners. The Greater Monument Butte Unit is a secondary recovery unit. This unit was approved by the BLM and the SITLA. In addition, the unit was approved by the Utah Board of Oil, Gas and Mining under Utah Statutes 40-6-7 and 40-6-8. The eight leases in question have undergone compulsory unitization and are considered fully committed to the unit area.

The terms of the Unit Agreement do not provide for contraction or elimination of lands from the Unit. Also, Utah Statute 40-6-8(5) explicitly provides:

5) An order providing for unit operations may be amended by an order made by the board in the same manner and subject to the same conditions as an original order providing for unit operations, provided:

(a) If such an amendment affects only the rights and interests of the owners, the approval of the amendment by the owners of royalty, overriding royalty, production payments and other such interests which are free of costs shall not be required.

(b) No such order of amendment shall change the percentage for the allocation of oil and gas as established for any separately owned tract by the original order, or change the percentage for allocation of cost as established for any separately owned tract by the original order.

Therefore the BLM has determined it is unlikely that the eight standard term leases which are committed to the Unit will be dropped from the Unit due to surface disturbance restrictions. However, for analysis purposes in the EIS it was anticipated that under Alternative D, some undetermined amount of oil and gas resources contained within these leases, (whatever can't be reached by directional drilling from areas outside the Core 1 areas) with the attendant royalties, taxes, and other revenues, would not be realized under Alternative D.

However, in accordance with the Endangered Species Act Section 7 (A) (3), as part of ongoing coordination between Newfield , BLM, and FWS, Newfield has estimated that eight new multi-well pads encompassing between 6 and 50 acres of surface disturbance would be necessary in Level 1 Core Conservation Areas for *Sclerocactus* to technically develop these leases. These eight well pads were not evaluated in the EIS agency preferred alternative, although they are included within the range of alternatives analyzed in the EIS. Since they are included in and are the primary subject of the FWS/Newfield cactus strategy (Attachment F), they are included for consultation in this Biological Assessment.

TABLE 2.1.3-1
SURFACE DISTURBANCE UNDER AGENCY PREFERRED ALTERNATIVE (ALTERNATIVE D)

Project Feature	**Size (disturbance width [ft.] or ac./facility)**	**Federal Lands**			**State Lands**			**Private Lands**			**Project Total**		
		Number or Miles	**Initial (short-term) Surface Disturbance (acres)**	**Residual (long-term) Surface Disturbance (acres)[1]**	**Number or Miles**	**Initial (short-term) Surface Disturbance (acres)**	**Residual (long-term) Surface Disturbance (acres)[1]**	**Number or Miles**	**Initial (short-term) Surface Disturbance (acres)**	**Residual (long-term) Surface Disturbance (acres)[1]**	**Number or Miles**	**Initial (short-term) Surface Disturbance (acres)**	**Residual (long-term) Surface Disturbance (acres)[1]**
Well Pads / Wells ***(Note: This table reflects GIS calculations of the conceptual number of locations available for construction and drilling in the project area based on the design parameters discussed in Section 2.6.3. Surface disturbance for well pads is based on the number of wells that could be drilled from each pad based on the design parameters discussed in Section 2.6.3. Although locations are available in excess of those proposed to be drilled under the proposed action, the total numbers of wells assumed to be drilled under this alternative would not exceed those evaluated under the Proposed Action. As such, well pad surface disturbance in this table is likely an overestimate.)***													
497 Existing, Large Well Pads													
Existing 40-ac Spacing Vertical Wells Located on Existing, Large Well Pads	--	432 existing pads	--	432	50 existing pads	--	50	15 existing pads	--	15	497 existing pads	--	--
New Vertical Gas Wells Located on Existing, Large Well Pads	0.8 acres per well	432 new wells	--	--	50 new wells	--	--	15 new wells		--	497 new wells	398	--
New Directional Gas Wells Located on Existing, Large Well Pads	0.2 acres per well	1,296 new wells	259	--	150 new wells	30	--	45 new wells	9	--	1,491 new wells	298	--
New 20-ac Spacing Directional Oil Wells Located on Existing, Large Well Pads	0.2 acres per well	432 new wells	74	--	50 new wells	9	--	15 new wells	3	--	497 new wells	99	--
1,041 Existing, Small Well Pads													
Existing 40-ac Spacing Vertical Oil Wells Located on Existing, Small Well Pads	--	893 existing pads	--	893	121 existing pads	--	121	27 existing pads	--	27	1,041 existing pads	--	--
New Directional 20-ac Spacing Oil Wells Located on Existing, Small Well Pads	0.2 acres per well	893 new wells	179	--	121 new wells	24	--	27 new wells	5	--	1,041 new wells	208	--
240 Proposed, Large Well Pads*													
New 40-ac Spacing Vertical Oil Wells Located on Proposed, Large Well Pads	2.0 acres per well	209 new wells	418	209	30 new wells	60	30	1 new well	2	1	240 new wells	480	240
New Vertical Gas Wells Located on Proposed, Large Well Pads	0.8 acres per well	209 new wells	167	--	30 new wells	24	--	1 new well	0.8	--	240 new wells	192	--
New Directional Gas Wells Located on Proposed, Large Well Pads	0.2 acres per well	627 new Wells	125	--	90 new wells	18	--	3 new wells	1	--	720 new wells	144	--
New Directional 20-ac Oil wells Located on Proposed, Large Well Pads	0.2 acres per well	209 new wells	2	--	30 new wells	0	--	1 new wells	0	--	240 new wells	48	--
1,005 Proposed, Small Well Pads**													
New 40-ac Spacing Vertical Oil Wells Located on Proposed, Small Well Pads	2.0 acres per well	869 new wells	1,738	869	117 new Wells	234	117	19	38	19	1,005 new wells	2,010	1,005
New 20-ac Spacing Directional Oil Wells Located on Proposed, Small Well Pads	0.2 acres per well	869 new Wells	174	--	117 new Wells	23	--	19	4	--	1,005 new Wells	201	--
Subtotal	**--**	**--**	**3,136**	**2,403**	--	**422**	**318**	--	**63**	**62**	**5,750 new wells*****	**4,078**	**1,245**
Total Number of New Well Pads		**1,078 new well pads**	**--**	**--**	**147 new well pads**	**--**	**--**	**20 new well pads**	**--**	**--**	**1,245 new well pads**	**--**	**--**
Access Roads													
New Roads Co-located with Pipelines	40 feet[2]	193 miles	939	939	31	150	150	1	7	7	226 miles	1,096	1,096
Existing Roads co-located with New Pipelines	10 feet[3]	280 miles	339	339	25	30	30	14	17	17	318 miles	385	385
Subtotal	**--**	**473 miles**	**1,278**	**1,278**	**56 miles**	**180**	**180**	**15 miles**	**24**	**24**	**544 miles**	**1,482**	**1,482**

Project Feature	Size (disturbance width [ft.] or ac./facility)	Federal Lands			State Lands			Private Lands			Project Total		
		Number or Miles	Initial (short-term) Surface Disturbance (acres)	Residual (long-term) Surface Disturbance (acres)[1]	Number or Miles	Initial (short-term) Surface Disturbance (acres)	Residual (long-term) Surface Disturbance (acres)[1]	Number or Miles	Initial (short-term) Surface Disturbance (acres)	Residual (long-term) Surface Disturbance (acres)[1]	Number or Miles	Initial (short-term) Surface Disturbance (acres)	Residual (long-term) Surface Disturbance (acres)[1]
Pipelines													
Pipelines Co-located with New Roads	60 feet[4]	193 miles	1,407	586	31	224	93	1	11	4	226 miles	1,644	685[5]
Pipelines Co-located with Existing Roads	60 feet[4]	280 miles	2,033	847	25	183	76	14	100	41	318 miles	2,313	963[5]
Subtotal	**--**	**473 miles**	**3,440**	**1,433**	**56 miles**	**407**	**169**	**15 miles**	**111**	**45**	**544 miles**	**3,958**	**1,647**
Central Facilities													
Compressor Stations (New and Upgrades)	9.4 acres (avg.)	22	207	207	2	19	19	0	0	0	24	226	226
Gas Processing Plants	10.0 acres	1	10	10	0	0	0	0	0	0	1	10	10
Water Treatment and Injection Facilities	8/5 acres[6]	12	78	78	1	8	8	0	0	0	13	86[7]	86
Gas and Oil Separation Plants (GOSPs)	22.0 acres	10	220	220	2	44	44	0	0	0	12	264	264
Fresh Water Collector Well	1.7 acres	1	0	0	0	0	0	0	0	0	1	1.7	7
Pump Stations	3.0 acres	5	15	15	1	3	3	0	0	0	6	18	18
Subtotal	**--**	**51**	**530**	**530**	**6**	**74**	**74**	**0**	**0**	**0**	**57**	**604**	**604**
Total New Disturbance	**--**	**--**	**8,782**	**4,319**	**--**	**1,130**	**570**	**--**	**210**	**89**	**--**	**10,122**	**4,978**

Source Note: Project totals for numbers of wells, miles of roads/pipelines, and numbers of facilities have been broken down by federal, state and private surface land categories for analysis purposes only. These totals represent a rough estimate based on conceptual locations of surface facilities and infrastructure.

1 Residual disturbance calculations are based on the assumption that interim reclamation will be initiated and successful.

2 Initial disturbance assumes that a 100-foot wide disturbance corridor would be needed for construction, of which 40 feet would be used for new road construction and 60 feet for pipeline/utility line installation.

3 Initial disturbance assumes that a 70-foot wide disturbance corridor would be needed for construction, of which 10 feet would be used for general road improvements and 60 feet for pipeline/utility line installation.

4 Initial disturbance assumes that a 60-foot wide disturbance corridor would be needed for pipeline/utility line installation within new and existing road ROWs.

5 Residual disturbance assumes that 35-foot wide portion of the original 60-foot wide disturbance corridor would be reclaimed leaving a 25-foot wide corridor for the long-term pipeline/utility corridor.

6 Each new water treatment and injection facility would occupy a site approximately 8 acres in size. Existing water treatment and injection facility locations proposed for expansion would be increased in size by approximately 5 acres each.

7 Includes 13 water treatment and injection facilities.

*Total pad size for each new, large well pad is anticipated to be 3.6 acres. Estimated disturbance per well on each new, large well pad is included for analysis purposes only.

** Total pad size for each new, small well pad is anticipated to be 2.2 acres. Estimated disturbance per well on each new, small well pad is included for analysis purposes only.

***Based on the well pad configuration the sum of the total number of wells under Alternative D may appear to be higher. However, BLM has assumed for analysis purposes that the number of wells drilled would not exceed that evaluated under the Proposed Action.

2.3 DEVELOPMENT ACTIVITIES

Newfield is proposing to expand its ongoing oil and natural gas development and secondary recovery within the MBPA using waterflood methods and deep gas operations. Waterflood methods involve the injection of produced water and freshwater (through formerly producing or new wells) into the oil-producing geologic formation. Nearby actively producing wells extract the fluids through the formation as the water displaces the oil. In addition, portions of the MBPA along the northwest and southern Project boundaries would be subject to expansion away from existing development.

Newfield proposes to drill new wells as infill to all productive formations, including but not limited to the middle and lower members of the Green River formation and upper member of the Colton Formation. The Green River oil wells would be drilled to a total depth of between 4,500 and 6,500 feet below ground surface (bgs), and the proposed deep gas wells would be drilled to a total depth of between 13,000 and 18,000 feet bgs.

The Alternative D map (see **Figure 2-4 – Attachment 1**) indicate conceptual locations of potential well pads from which oil and natural gas resources could be developed. Per comments received by the BLM from the State of Utah, a Cooperating Agency on this EIS, the State assumes that Newfield would assume full recovery of State mineral resources. The extent of such development and prospective nature of the resources is based on three-dimensional (3D) seismic data, geologic information, data derived from wells drilled to date, and economic factors.

Well density in the MBPA would vary based on geologic characteristics of the formation being targeted for development. The range of downhole well densities expected at this time is one well per 20 acres (i.e., middle member of the Green River Formation) to one well per 40 acres (i.e., middle and lower members of the Green River Formation). The ultimate number and density of wells would be defined through future drilling. Newfield would use directional drilling and multiple well pad drilling techniques to develop these resources in a manner that would limit the number of well pads or surface locations (i.e., surface density) to a maximum of one well pad per 40 acres.

The number and types of wells per well pad would vary based on downhole spacing, technical feasibility, and the geologic characteristics of the targeted formation. Some well pad locations would host a single well, and others may have multiple wells drilled from a single well pad.

Figure 2.6-1 shows the existing high- and low-density development areas within the MBPA. High-density development areas are those areas that have from six to 16 well pads per 640-acre section (i.e., one well pad per 40 to 106 acres). Low-density development areas are those areas that have had no gas development at all or contain up to five well pads per section.

Of the 197 sections or portions of sections within the MBPA, 115 (about 58 percent) are within the high-density development areas. Average existing surface disturbance within the high-density development areas is 39.0 acres per section, and the average number of well pads per section is 14.3. Approximately 82 sections or portions of sections occur within the low-density development areas. The average existing disturbance within the low-density development areas is 11.9 acres per section, and the average number of existing well pads per section is 2.8.

The life cycle of an individual well and its associated facilities/required infrastructure (e.g., roads, pipelines, and compressor stations) is composed of seven primary phases: (1) preconstruction, (2) construction, (3) drilling, (4) completion, (5) interim reclamation, (6) production and maintenance, and (7) final reclamation and abandonment.

2.3.1 Pre-Construction Activities

2.3.1.1 Surveying and Notice of Staking or Application for Permit to Drill

Prior to the start of construction activities on BLM-managed lands, Newfield would initiate the well-permitting process by filing either a NOS or an APD with the BLM VFO, which would start the application process to ensure that it meets applicable requirements. For wells on split estate lands, Newfield would follow the requirements of *Section VI, Onshore Oil and Gas Order No. 1*, for notifying and obtaining an access agreement with the surface owner.

A complete APD normally consists of a SUPO, Drilling Plan, evidence of bond coverage, shapefiles, and other information required to comply with *Onshore Oil and Gas Order No. 1*. A SUPO contains information describing construction operations, access, water supply, well site layout, production facilities, waste disposal, and restoration/revegetation or reclamation associated with the site-specific well development proposal. The Drilling Plan typically includes information describing the technical drilling aspects of the specific proposal, safety specifications, and subsurface resource protection. Determination of the suitability of Newfield's design, construction techniques, and procedures would be made by the appropriate AO during the initial permitting process. This Federal Oil and Gas Onshore Order applies to federal minerals.

2.3.1.2 On-Site Inspection and Construction Initiation

Prior to APD approval and construction, Surface Management agency (SMA) personnel would conduct on-site inspections to assess potential impacts and recommend additional methods to mitigate impacts. The SMA may impose COAs to the APD based on site-specific analysis and the NEPA process. These additional environmental protection measures would cover all aspects of oil and gas development, including construction, drilling, production, reclamation, and abandonment. The SMA would arrange a date, time, and place to meet with Newfield to perform an on-site inspection. Survey stakes, with cut and fill footages, would be used to indicate the orientation of the well pad, and flagging would be used to indicate the routing of access roads, pipelines, or other linear features.

Changes or modifications would be made during the inspection, if needed, to avoid or mitigate impacts to natural and cultural resources. Cut and fill and construction issues also would be addressed, as necessary. For wells on BLM-managed leases, provisions of 43 CFR 3101.1-2 and the BLM standard lease (Form 3100-11) allow for the relocation of the proposed well by up to 650 feet and a subsequent delay in operations of up to 60 days.

2.3.2 Proposed Construction Activities

2.3.2.1 Well Pad Construction

As previously discussed, one of the primary goals of Alternative D is to reduce surface disturbance. As a result, the alternative includes enhanced use of existing well pads, as well as increased use of directional drilling from new and existing pads. Under this scenario, Newfield could expand approximately 497 existing, large well pads, and 1,041 existing, small well pads. Newfield could also construct approximately 240 new, large well pads, and 1,005 new, small well pads. If all of these pads were expanded/constructed in accordance with the well development scenario discussed in **Section 2.1.3**, initial disturbance from well pad construction could be up to 4,078 acres. Following well completion(s), portions of the well pad not needed for production would be reseeded and reclaimed according to specifications of the appropriate SMA. Assuming successful interim reclamation, long-term well pad disturbance under Alternative D would be reduced to approximately 1,245 acres.

Prior to well pad construction or surface-disturbing activities, Newfield would obtain approval of an APD by the BLM AO. The APD would contain site-specific COAs that would apply to construction and well operations. Construction of well pads would typically begin with stripping and stockpiling topsoil. The top 4 to 6 inches of topsoil material (preferably all topsoil) would be stockpiled for use in interim reclamation.

Following topsoil removal and stockpiling, each well pad would be constructed using standard cut-and-fill techniques to create a level pad needed for drilling operations. With associated cut and fill slopes, single Green River oil wells with a 40-acre surface density would be constructed to average dimensions of approximately 225 feet x 400 feet (2 acres in size), while vertical deep gas wells with a 40-acre surface density would be constructed to average dimensions of approximately 275 feet x 475 feet (3 acres in size). Well pads hosting multiple wells and/or horizontal wells would be approximately 0.2 acres per well larger than the 2 to 3-acre average.

Primary surface equipment to be installed at each well pad would include a drilling rig, reserve pit or closed-loop system, mud tank, dog house flare pit, pipe racks, pump house, trailers, water storage tanks, and generators. The typical layout for a single well pad is illustrated in **Figure 2.2.2.1-1 (Attachment 1)**.

Fill slopes, where necessary, would be compacted and maintained to maximize slope stability and minimize erosion. Where cut and fill slopes are required, they would be constructed at no steeper than a 3:1 ratio. Engineering design would ensure that cut and fill volumes of soils would generally be balanced to ensure all materials generated during construction are used to the greatest extent practicable, and that few or no spoil piles remain.

Once the pad has been leveled and graded, it would be compacted to establish a level and solid foundation for the drilling rig. The site preparation process would take approximately 3 to 4 days to complete. The well pad would be constructed to prevent surface run-on by channeling flow within diversion ditches and energy dissipaters (if needed) around the site and then released to grade, consistent with Best Management Practices (BMPs) for erosion control.

The number of well pads constructed per section or in a given area (and associated number and type of wells drilled from that pad) is an assumption for analysis purposes. The actual number of well pads per section or in a given area may vary due to resource restrictions, but BLM does not anticipate that this variation would result in an exceedance of the overall numbers assumed for analysis.

2.3.2.2 Reserve Pits and Flare Pits

The reserve pit would be constructed on the well pad for the containment and temporary storage of drill cuttings and drilling mud for no more than 90 days (43 CFR 3160.7). The reserve pit would be sized appropriately depending upon the number and type of wells that would be drilled from the individual well pad. The largest proposed reserve pit would be approximately 185 feet long by 100 feet wide by 8 feet deep and would hold approximately 830,338 gallons. All reserve pits would be designed to maintain a two-foot freeboard[3].

Where possible, reserve pits would not be constructed in fill material. Where cut material locations are not possible, or where sensitive areas exist, a closed-loop system, with above ground tanks in lieu of a pit, would be considered at the discretion of the AO. The reserve pit would be constructed by mechanical compaction and lined to prevent loss of drilling water. The pits would be lined with a reinforced polyethylene liner a minimum of 16-mil thickness, with sufficient bedding used to cover any rocks. The liner would overlap the pit walls and be anchored with dirt and/or gravel to hold it in place. The reserve pit would be constructed and operated in accordance with UDOGM rule R649-3-16 – *Reserve Pits and Other On-site Pits* and in accordance with *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development* (BLM 2007a). This publication will be referenced hereafter as the *Gold Book*. The *Gold Book* provides practices and standards to guide compliance with applicable agency policy, operating guidelines, and BMPs. The reserve pit would be fenced on three sides during drilling to prevent wildlife or livestock from entering the pit. Once drilling is complete, all sides would be fenced. Recontouring would be completed within 180 days.

2.3.2.3 Access Roads

Implementation of Alternative D would require the construction of up to 226 miles of new access roads and expansion and/or upgrades to approximately 318 miles of existing roads. The initial surface disturbance resulting from the construction of new access roads and expansion and/or upgrades to existing roads would be approximately 1,096 acres and 385 acres, respectively.

A network of roads already exists within the MBPA. These roads would be used as is or upgraded where needed to access well pads or other surface facilities. New roads would be constructed only where necessary, because new roads have been sited and designed to minimize disturbances and maximize transportation efficiency. New roads would be built and maintained to provide year-round access, as necessary. Bulldozers, graders, and other types of heavy equipment would be used to construct and maintain the road system.

All access roads would be constructed out of native material and to the standards outlined in the *Gold Book*. Following staking of the road corridor and on-site review, the road design plan would be approved and any engineering needs specified. After road approval, standard cut and fill construction methods and construction equipment would be used to construct new roads. A typical roadway cross-section with width specifications is shown in **Figure 2.2.2.3-1 (Attachment 1)**.

All roads would be constructed with appropriate drainage and erosion control features (e.g., cut and fill slope and drainage ditch stabilization, relief and drainage culverts, wing ditches, and rip-rap). Where needed, road base or gravel would be placed on upgraded and newly-constructed roads to provide a stable travel-way surface. Aggregate for road surfacing would be obtained from existing, permitted quarries from permitted sources. Aggregate would be of sufficient size, type, and amount to allow all-weather access and to minimize fugitive dust.

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[3] Freeboard is the vertical distance between the normal maximum level of the water surface in a channel, reservoir, tank, canal, etc., and the top of the sides of a levee, dam, etc., which is provided so that waves and other movements of the liquid will not overtop the confining structure.

In steep terrain, a construction technique known as side casting (using the material taken from the cut portion of the road to construct the fill portion) would be used. Slightly less than half of the roadbed would be placed on a cut area; the remainder would be placed on a fill area. Soil texture, steep road grades, and moisture conditions would dictate whether the access road would be surfaced with commercial road base or shale. Water or other approved surfactants, such as magnesium carbonate, would be used to control dust during construction.

All necessary County planning and zoning permits would be secured prior to road construction, and maintenance agreements would be signed with the counties where Class B and Class D county roads would be used for daily operations in the MBPA. These agreements would include provisions for the maintenance and upkeep of county roads by Newfield to enhance their functional use and safety. All roads would meet minimum *Gold Book* and BLM Manual 9113 standards for construction.

The number of pipelines and utilities required, and the spacing between pipelines, utilities, and roads required for safe operations, would define the necessary corridor width. Where new co-located roads and pipeline ROWs are proposed, an initial disturbance corridor up to 100 feet in width would be needed for construction purposes. Of the initial 100-foot wide corridor, a 40-foot width would be used for road construction, and 30-foot-wide corridors on each side of the road would be used for the installation of pipelines (see **Section 2.3.2.4**). One side of the road would be used for both buried and surface lines where possible, and both sides of the road would be used as necessary based on existing infrastructure or topography. Typically, a buried pipeline is installed directly adjacent to the road and in bar ditch that is 10 to 15 feet wide. The 30-foot-wide corridor is allowed for construction and does not reflect the entire width of disturbance in the ROW.

Existing road ROWs would require an expansion width of approximately 70 feet, of which 10 feet would be needed for general road improvements (i.e., recontouring, borrow ditches, and stormwater management) and the remaining 60 feet would be used for the installation of pipelines. Following reclamation, a 10-foot width would remain for the long-term road ROW in addition to the existing road width, and a 25-foot width would remain for the long-term pipeline ROW. A typical roadway cross-section with pipeline installation alongside the road is shown in **Figure 2.2.2.3-2 (Attachment 1)**.

Construction of new roads or upgrading of existing roads would typically take 1 to 2 days per mile of road. Primary access roads/trunk roads (i.e., those providing access through the MBPA or to multiple well pads) or roads constructed or upgraded in steep terrain would require more time to complete - approximately 2 to 3 days per mile of road. Spur roads to individual well pads would be constructed immediately prior to well pad construction. For trunk roads, several crews could operate simultaneously on different roads or different portions of the same road. Total personnel working on trunk road construction or improvements could range in size from 10 to 25 individuals. Each spur road workforce would include an average of five personnel to operate the equipment.

2.3.2.4 Pipeline Construction

Under Alternative D, approximately 226 miles of pipeline would be installed adjacent to proposed access roads (co-located) and approximately 318 miles of pipeline would be installed along existing roads. Installation of pipelines along proposed and existing roads would result in approximately 1,644 acres and 2,313 acres of initial surface disturbance, respectively. In limited situations, a proposed pipeline would be installed independent of an access road (i.e., cross-country). Under Alternative D, an estimated 40 miles of cross-country pipeline could be installed. Based on a 50-foot-wide corridor, cross-country pipelines could result in approximately 242 acres of surface disturbance. As there are no conceptual locations for cross-country pipelines, they are not shown on maps for Alternative D, nor are they included in the GIS-based disturbance calculation tables.

The existing pipeline gathering system within the MBPA would be expanded as development progresses. Proposed pipelines for new development would be integrated into the existing pipeline network within the MBPA. These include gas and liquid gathering pipelines, water injection pipelines, produced water pipelines, and fuel lines. Water distribution lines, injection lines, and high-pressure gas pipelines would be buried, while oil gathering lines, low-pressure gas lines, and fuel lines would be installed on the ground surface.

Pipeline expansion would typically be accomplished by looping or paralleling existing lines with additional lines and by adding compressors within the existing and planned facilities. A loop pipeline is defined as a pipeline that is constructed near an existing pipeline, which is placed in service concurrently for the purpose of adding capacity to the existing system.

All high-pressure gas lines would be buried unless constrained due to topography or surface geology. All low-pressure gas lines would be placed on the surface. New gas gathering lines would be constructed of steel pipes from 4 to 10 inches in outer diameter. Each gathering line would tie into a larger 10- to 16-inch outer diameter trunk line that would eventually transport the gas to compression facilities located in or near the MBPA. Typical pipeline installation scenarios with width specifications are shown in **Figure 2.2.2.3-2** and **Figure 2.2.2.4-1 (Attachment 1)**.

Water pipelines would be needed to transport produced water to the water treatment facilities and to transport fresh and recycled water to the injection wells for waterflood purposes. Water pipelines would be from 4 to 8 inches in diameter and constructed from steel and/or polypropylene. These water pipelines would be buried to prevent freezing and would be installed in conjunction with (alongside) the high-pressure gas gathering pipelines, where possible.

Surface gathering lines would be buried where they intersect with access roads. Each pipeline ROW could include multiple gas gathering pipelines (both low and high pressure systems with potential loop lines), fuel gas pipelines, oil gathering pipelines, as well as produced water and water injection pipelines. This would initially involve widening the disturbance corridor along the existing roadway by approximately 60 feet to accommodate the proposed gas gathering pipelines and water pipelines. Following pipeline installation, approximately 35 feet (or more if buried) of the pipeline ROW width could be reclaimed, leaving a 25-foot width for the long-term pipeline ROW[4].

In limited situations (for example, to reduce total pipeline length), a proposed pipeline ROW would be installed independent of an access road. Pipelines installed independent of roads (e.g., cross-country pipelines, or water pipelines for the water collector well) is anticipated for fewer than 10 percent of all pipelines.

[4] The term ROW is used throughout this document to describe access road, pipeline, and utility line corridors, even though a true BLM ROW may not be required.

The decision to bury a cross-country pipeline versus laying it on the surface would depend upon the soil conditions, terrain, and product being piped. New cross-country pipelines would require a 40- to 50-foot-wide construction ROW, depending on whether they are laid in the surface or buried. The exact location of pipelines would be determined at the time of the on-site inspection with the appropriate SMA. As conceptual locations for cross-country pipelines are not yet known, they are not reflected in the Alternative D map. A rough estimate of disturbance from cross-country pipelines is included in the narrative description of Alternative D, but it is not reflected in the GIS-based surface disturbance tables or the resource-specific surface disturbance calculations in Chapter 4.

Generally, pipeline construction would occur in a planned sequence of operations along or within road ROWs. For buried pipelines, the pipeline trench would be first cleared of vegetation by blading the surface only if necessary to stabilize equipment. The pipeline trench would then be excavated mechanically with either a trencher or backhoe to a depth of approximately 36 inches. The width of the trench would range from approximately 18 to 36 inches, depending on the number of co-located pipelines and the diameter of pipe placed in the trench bottom. Pipe laying activities would include pipe stringing, bending, welding, coating, lowering of pipeline sections into the trench, and backfilling. Surface pipelines adjacent to roads would be assembled on the roadway or construction ROW, lifted, and placed in the existing vegetation using a side-boom.

Each gathering pipeline would be tested with pressurized fresh water or air to locate any potential leaks. Fresh water used for hydrostatic testing would be obtained from existing, permitted water supply sources (see **Table 2.3.8.3-1**). These sources would consist of both ground water from wells, surface withdrawals from permitted sources, and from Newfield's proposed water collector well along the Green River. Withdrawals would be made from suppliers that hold existing water rights permits through the Utah Division of Water Rights. After completion of hydrostatic testing, waste water would be taken to Newfield's water injection facility, where it would be treated and reused for waterflood purposes.

2.3.2.5 Compressor Stations

Under Alternative D, Newfield would construct up to 24 new compressor stations within the MBPA. Each station would occupy an approximate 9.6 acre site and would produce up to 8,000 hp of compression. Compressor stations would not be reclaimed until they are no longer needed (up to 50 years), resulting in prolonged surface disturbance of approximately 226 acres.

Expansion plans for the existing compressor stations would include the installation of additional compressor units or replacing smaller capacity units with larger ones. Each new compressor would be built with up to 8,000 horsepower (hp) of compression. Compressor station locations would be constructed similar to well pads as described in **Section 2.3.2.1**. Each site would be constructed to approximately 730 feet x 600 feet (10 acres in size). Surface disturbance of existing compressor stations would be approximately 2.8 acres per facility.

Associated equipment to be installed at each compressor station would include an inlet separator (unfired); a 50-million standard cubic feet per day (MMscf/d) dehydrator; four 400-bbl atmospheric production tanks; one flare (used for emergency relief); one vapor control unit used to control stock tank and dehydrator emissions; and dew point control equipment with a pressurized natural gas liquid (NGL) storage bullet and associated truck loading rack. A typical layout for a compression station is shown in **Figure 2.2.2.5-1 (Attachment 1)**.

Existing compressor stations for the Green River wells within the MBPA would be expanded by approximately 5 acres each to accommodate additional facilities, which would include up to 5,000 hp of additional compression. The expanded compressor stations would occupy approximately 10 acres and include up to 8,000 hp of compression. Primary equipment to be installed at each expanded compressor station would include an inlet scrubber, one 50-MMscf/d dehydrator, four 400-bbl atmospheric production tanks, an emergency flare and a vapor control unit, and one gas conditioning refrigeration unit with a pressurized NGL storage bullet and associated truck loading rack.

2.3.2.6 Central Gas Processing Plant

Following compression, gas would be transported by a 10-inch gas gathering line to one proposed centralized gas processing plant that would be constructed to process up to 50 MMscf/d. The conceptual location for the proposed gas processing plant is presented on **Figure 2-4 (Attachment 1)**. Construction of the proposed gas processing plant would be essentially the same as that previously described for the well pad and compressor station sites (see **Section 2.3.2.1**).

The processing plant would occupy an approximate 10-acre site. Primary surface equipment to be installed would include four 300-hp compressors; one flare; one vapor control unit; one 50-MMscf/d dehydrator; and one load out rack. Surface disturbance of the existing gas processing plant would be approximately 3.2 acres.

Central facilities, including the proposed central gas processing plant, would not be reclaimed during interim reclamation, because the total area of initial surface disturbance would be needed for operational activities. Therefore, the residual long-term surface disturbance would be the same as the initial surface disturbance of approximately 10 acres.

2.3.2.7 Water Treatment and Injection Facilities

Under Alternative D, up to 13 new or existing water treatment and injection facilities would be constructed and/or expanded within the MBPA. The proposed water treatment facilities would be used for recycling of produced water that would either be co-mingled with fresh water and piped for waterflood injection wells, or trucked from the facility to be used at subsequent wells for completion activities. Equipment at each facility would include four 500-hp main injection pumps, four 125-hp auxiliary injection pumps, up to six 500-bbl oil tank,; up to 10 500-bbl inlet water tanks, six to eight 5,000-bbl water storage tanks- one vapor control unit, and a natural gas-fueled generator for pumping.

Each treatment and injection facility would be connected to nearby proposed injection wells by a series of buried water injection pipelines. Water intended for dust suppression or reuse in drilling or completion activities would be trucked from the injection facilities to drilling locations. Produced water not suitable for waterflood purposes or dust suppression would be trucked from treatment and injection facilities to permitted disposal wells within the MBPA. There are currently nine existing injection facilities which have disturbed an area of approximately 3.1 acres per location.

Each new water treatment and injection facility would occupy a site approximately 8 acres in size. Existing water treatment and injection facility locations proposed for expansion would be increased in size by approximately 5 acres each. Therefore, the initial surface disturbance resulting from the construction of five new water treatment and injection facilities and expansion of five existing facilities would be approximately 86 acres.

As with other production facilities, water treatment and injection facilities would not be reclaimed during interim reclamation, because the total area of initial surface disturbance would be needed for operational activities. Therefore, the residual long-term surface disturbance would be the same as the initial surface disturbance of approximately 86 acres.

2.3.2.8 Gas and Oil Separation Plants (GOSPs)

Under Alternative D, up to 12 new GOSPs would be constructed that would be used for the initial separation of produced water and gas from the oil prior to shipment to the refinery for further processing. Conceptual locations for GOSPs are illustrated on **Figure 2-4 (Attachment 1)**. Each new GOSP would occupy a 22-acre site and would remain in use for the anticipated LOP (up to 50 years), resulting in long-term disturbance of approximately 264 acres. Construction of the GOSPs would be essentially the same as that previously described for the well pad and compressor station sites. There is one existing GOSP in the Project Area which has disturbed approximately 16 acres.
Surface facilities at each GOSP would consist of the following:

- Eight electric motor driven 200-hp pumps;
- Up to seven free water knock outs (FWKOs);
- Up to three heater treaters;
- Up to four 5,000-bbl oil tanks; One (1) 5,000-bbl water tank;
- One emergency flare;
- Two vapor combustion units (VCUs);
- Tanker truck oil load out racks;
- Three 11-million British Thermal Units (MMBtu)/hr natural gas fueled process heaters;
- One primary and one backup 1,400 kW generators driven by gas fueled engines; and
- Two pipeline pig receivers.

Produced fluids consisting of black wax hydrocarbons, produced water and entrained natural gas gathered from wells in the MBPA would be delivered by pipeline to the GOSPs. The design process rate for each GOSP facility would be 10,000 barrels per day (bbls/day), consisting of approximately 5,000 bbls/day of oil and 5,000 bbls/day of produced water. As the MBPA field oil production rate continues to decline, the ratio of oil to produced water, and the oil-related volatile organic compound (VOC) emissions, would decrease over time. A typical layout for a GOSP is shown in **Figure 2.2.2.8-1 (Attachment 1)**.

Each GOSP would be designed to minimize VOC emissions by eliminating hydrocarbon emission sources when possible, recycling hydrocarbon gas streams when feasible, and destroying excess hydrocarbons when necessary. The gas collected from the FWKOs and heater treaters would be captured and compressed for reuse or sale. The produced gas compressors would be driven by electric 200-hp motors. The captured produced gas would be recycled and used for fuel at each GOSP. Fuel would be treated by a sulfur removal tower prior to use. The sulfur removal tower is a closed unit and would have no emissions under normal operations.

Fuel gas from the MBPA system would normally augment the fuel gas supply at each GOSP. When produced gas volumes exceed the needed fuel at a GOSP, the excess gas would be routed to the existing wet gas gathering system for treatment and compression prior to sale.

2.3.2.9 Pump Stations

Under Alternative D, six water pump stations would be constructed to ensure delivery of water to treatment and injection facilities. Each new pump station would occupy a 3-acre site, resulting in a total long-term disturbance of 18 acres. Pump station facilities would include one 200-hp water pump and up to two 400-bbl water storage tanks.

2.3.3 Well Drilling

Based upon current technology and drilling rates in the MBPA, up to 12 drilling rigs could be active in the MBPA at any given time. Depending on the type of well drilled (i.e., Green River oil well or deep gas well), an average of 360 wells would be drilled annually. Also, based on the amount of time needed to drill a deep gas well, the timeframe to fully explore and develop the resource may need to be extended up to 30 years, based on commodity pricing for natural gas.

Drilling operations would be conducted in two phases. A small conventional drilling rig, similar to a water well rig, would drill to a depth of approximately 600 to 1,000 feet bgs, or 50 feet below any usable water encountered. Water that is defined as “usable” has less than or equal to 10,000 mg/L total dissolved solids. Federal Safe Drinking Water Act regulations define an Underground Source of Drinking Water (USDW) as an aquifer or portion thereof: (a)(1) which supplies any public water system; or (2) which contains a sufficient quantity of ground water to supply a public water system; and (i) currently supplies drinking water for human consumption; or (ii) contains fewer than 10,000 mg/l total dissolved solids; and (b) which is not an exempted aquifer (See 40 CFR Section 144.3). The annular space between the borehole and the surface casing for the entire length of the surface casing would be sealed with cement to isolate any USDWs encountered near the surface. As the borehole is dug, the drilling mud between the casing and the borehole prevents migration of oil and gas to USDWs. When the well is cemented, the cement is inserted at the bottom of the hole under pressure, and as the cement rises, it forces the drilling mud up and out of the borehole. By using this procedure, there is never an open hole for oil or gas to migrate to USDWs. A cement bond log would be run to ensure that the seal is adequate. This part of the drilling operation would normally take 2 to 3 days to complete.

Upon completion of drilling the surface hole, a larger industry standard rotary drill would drill to the total target depth. Drilling operations would include: adding new joints of pipe at the surface as the hole deepens and using multiple casing strings when deemed necessary, circulating drilling mud to cool the drill bit and remove the cuttings, removing the drill string from the hole to replace worn drill bits, and setting production casing and cementing it in place. Well-specific casing designs and depths would be approved by the appropriate agencies during the APD process. Cement would overlap 200 feet into the previous casing strings annular space between the borehole and the production casing, isolating any USDWs encountered at depth with the method previously described. Green River oil wells would be drilled to a total depth of between 4,500 and 6,500 feet bgs, and the proposed deep gas wells would be drilled to a total depth of between 13,000 and 18,000 feet bgs, depending on the target formation.
Prior to drilling below the surface casing, a blow-out preventer (BOP) would be installed on the surface casing, and both the BOP and surface casing would be tested for pressure integrity. The BOP and related equipment would meet the minimum requirements of *Onshore Oil and Gas Order No. 2*. The BLM would be notified in advance of all pressure tests in order to witness those tests, if it so desired.

The drilling contractor may run a downhole mud motor to increase the penetration rate. The rig would pump fresh water as a circulating fluid to drive the mud motor, cool the drill bit, and remove cuttings from the wellbore. In order to achieve borehole stability and minimize possible damage to the hydrocarbon producing formations, a potassium chloride substitute and commercial clay stabilizer may be added to the drilling fluid. In addition, 10 to 20 gallons of polyacrylamide polymer (PHPA) per 1,000-bbls could be added to the drilling fluid to provide adequate viscosity to carry the drill cuttings out of the wellbore. From time to time, other materials may be added to the fluid system, such as sawdust, natural fibers, or paper flakes, to reduce downhole fluid losses. In addition, with deeper wells, barite weighting material may need to be added to the mud system to control formation pressures and to provide borehole stability.

Upon drilling each well to an intermediate depth, a series of logging tools would be run in the well to evaluate the potential hydrocarbon resource. Steel production casing would then be run and cemented in place from surface to an intermediate depth in accordance with the well design, and as approved by the BLM in the APD and any applicable COAs. The casing and cementing program would be designed to isolate and protect USDW formations encountered in the wellbore, to prohibit pressure communication or fluid migration between zones by using the resource protection guidance outlined in *Onshore Oil and Gas Order No. 2* and UT IM 2010-055, and to provide a structural platform to attach well control equipment. The types of casing used, and the depths to which they are set, would depend upon the physical characteristics of the formations that are drilled and would be specified in the APD for each well. All casing would be new or inspected previously used casing. Where necessary, intermediate and/or production casing would subsequently be run to total depth. The BOP equipment would be re-tested prior to drilling the final section of the well below the intermediate casing point.

Following the completion of drilling operations and prior to running the casing to total depth, open hole well logs may be run to evaluate a well's production potential. If the evaluation concludes that adequate hydrocarbon resources are present and recoverable, then steel production casing would be run to total depth and cemented in place, in accordance with the well design and as approved by the BLM. The casing and cementing program would be designed to isolate and protect the formations, members, or zones potentially containing usable water, oil, gas, or prospectively valuable deposits of other minerals encountered in the wellbore and to prohibit pressure communication or fluid migration between zones.

Drilling operations would occur on a 24-hour per day basis. Drilling activities would take approximately 5 days for a vertical or a directional Green River oil well, 21 days for a horizontal Green River oil well, and approximately 55 days for a vertical deep gas well. Drilling activities would require approximately 12 personnel per well. An average of 360 wells would be drilled per year: therefore, up to eight drill rigs (i.e., four Green River oil rigs and four deep gas rigs) could be in the MBPA at any given time.

Drilling would be conducted in compliance with all Federal rules and regulations, including Federal Oil and Gas Onshore Orders, all State UDOGM rules and regulations, and all applicable local rules and regulations. Site-specific descriptions of drilling procedures would be included in the APD, and additional regulatory measures may be specified in the COAs for each well. Information relative to size of the borehole (usually 5 to 24 inches), casing, and cementing would also be contained in the site-specific APDs.

In the event it becomes necessary to flare a well, flare lines would be directed to flare pits to avoid environmental damage and as required by regulations. A deflector and/or directional orifice would be used to safeguard project personnel and other natural resources.

An example well bore diagram is provided in **Figure 2.2.3-1 (Attachment 1)**.

2.3.4 Well Completion

After a well is drilled and production casing is set, a completion unit would be moved on location to perforate and stimulate the reservoir. The casing would be perforated across the productive zones, followed by a stimulation treatment of the formation to enhance its transmissibility of oil and gas. Hydraulic fracture stimulation is required on the majority of wells in the MBPA to enhance productivity. All hydraulic fracturing activity would be in compliance with BLM and UDOGM hydraulic fracturing rules and notices. Water/sand slurry would be used with gels and other non-toxic chemical additives to ensure the quality of the fracture fluid. Fluid would be pumped down the well through perforations in the casing and into the formation. Pumping pressures would be increased to the point at which fractures occur in the rock formations and radiate outward from the perforations into the target formation. The slurry that flows rapidly into the fractures and the sand in the slurry mix would serve as a proppant to keep the created fracture open after the fracture treatment, thereby allowing reservoir fluids to move more readily into the well. Water use during drilling and completion operations would vary in accordance with the characteristics of the formations the wells are completed in, but would average approximately 7,000 bbls (0.9 acre-feet) for a Green River oil well and up to 48,000 bbls (6.2 acre-feet) for a deep gas well.

Typical equipment and vehicles used during completion activities would include carbon dioxide (CO_2) tanker trucks; sand transport trucks; water trucks; oil service trucks used to transport pumps and equipment for fracs; flat beds and gin pole trucks to move water tanks, rigs, tubing, and frac chemicals; logging trucks (cased hole wireline trucks); and pickup trucks to haul personnel and miscellaneous materials and equipment.

Completion activities would take place on a 24-hour basis, requiring approximately 14 workers. Green River oil well completions would take an average of 6 to 7 days for vertical or directionally drilled Green River wells. Horizontal well completions would take up to 10 days to complete. Completion activities on the deep gas wells would require an average of 24 days, depending on the number of completion zones. If flaring is necessary during completion operations, flaring would take place as described in **Section 2.3.3**.

2.3.5 Interim Reclamation

For the complete reclamation and weed control plan for this project, refer to **Appendix D**. Under Alternative D, approximately 50 percent of surface disturbance associated with construction of proposed well pads and expansion of existing well pads, road and pipeline ROWs, and other project facilities not needed for operational purposes would be reclaimed. This would reduce the long-term disturbance associated with implementation of Alternative D to approximately 4,978 acres.

Interim reclamation consists of minimizing the footprint of disturbance by reclaiming all portions of well pads, ROWs, and other surface facilities not needed for production operations. The portions of the well site and other project facilities that are not needed for operational and safety purposes would be recontoured to a final or intermediate contour that blends with the surrounding topography as much as possible. Stockpiled topsoil would be re-spread over areas not needed for all-weather operations. When practical, topsoil would be re-spread over the entire location, roughened to enhance water catchment and revegetated to within a few feet of the production facilities; unless an all-weather surfaced access route or turnaround is needed.

Some locations would require special reclamation practices. Methods such as hydromulching, straw mat application on steeper slopes, fertilizing, and soil analysis to determine the need for fertilizer, seed-bed preparation, contour furrowing, watering, terracing, water barring, and the replacement of topsoil would be implemented as directed by the SMA. Interim reclamation surface disturbance associated with the proposed project would be implemented in accordance with the *Green River District Reclamation Guidelines for Reclamation Plans* (BLM 2011a). These guidelines would apply to interim reclamation activities in the MBPA and include measurable standards as well as the monitoring and reporting of compliance with the reclamation standards. The Green River District has developed a web-based reclamation database entitled the “Green River Database Management System”. This system allows operators or contractors to submit reclamation reports. Reclamation reports associated with this Project will be submitted via this database.

Prior to interim reclamation activities, all solid wastes and refuse would be removed and transported to an approved landfill. Upon completion of a producing well site, all reserve pits, cellars, rat holes, and other boreholes unnecessary for further well operations would be promptly backfilled. Reserve pit closure would be subject to COAs determined through the APD process. Any hydrocarbons in the reserve pit would be removed and processed or disposed of at an appropriate offsite commercial facility. Cuttings generated during the drilling process would be buried in the reserve pit following the evaporation or removal of free liquids. The reserve pits would be drained and emptied of fluids within 90 days and closed within 6 months of well completion per the requirements of *Onshore Oil and Gas Orders No. 7*, subject to weather conditions. The pit liner would be folded into the reserve pit and the pit backfilled. Backfilling of each reserve pit would be done in such a manner that the mud and associated solids would be confined to each pit and not incorporated in the surface materials. The reserve pit and that portion of the location not needed for production facilities/operations would be recontoured to the approximate natural contours and crowned slightly to prevent water from standing. All of the topsoil would be spread over the recontoured area and then seeded to promote topsoil viability. All disturbed areas would be reclaimed with a seed mixture of pure live seed (PLS) accepted and approved by the AO.

2.3.6 Production, Operation, Hydraulic Fracturing, and Maintenance Activities

2.3.6.1 Production and Operations

Production facilities would be installed on the well pad when a well is determined to be commercially productive. Newfield may eventually employ the use of centralized tank batteries (CTBs) as multiple wells are brought into production within a given area. Each CTB would centralize the location of the production equipment for multiple wells, thereby reducing surface facilities on individual pads. As CTBs are constructed and become operational, daily well maintenance traffic would be reduced. The number and locations of potential CTBs would be highly dependent upon the surrounding topography and proximity to the wells contemplated for inclusion at the individual CTB. In some cases, a stand-alone tank would be necessary. For the purposes of analysis, it is assumed that all CTBs would be located on proposed GOSPs.

Permanent aboveground structures, including pumping units, would be painted a flat, non-reflective, earth-tone color on the BLM’s Standard Environmental Color Chart, as determined by the AO. Facilities would be painted within 6 months of installation. As required by the Occupational Safety and Health Administration (OSHA), some equipment would not be painted for safety considerations (i.e., some parts of equipment would retain safety coloration).

2.3.6.1.1 Green River Oil Wells

Primary production equipment at the Green River oil wells would include the wellhead; a pumpjack driven by a natural gas fueled engine; a heater treater to separate oil, gas, and water; two 400-bbl oil/production tanks; and one 200-bbl produced water tank. Ancillary equipment on each of the well pads may include 150-gallon chemical storage drums, 55-gallon motor oil drums, and 55-gallon methanol storage drums.

As the GOSP system is phased in, Newfield would remove tanks and heater treaters from individual well pads that are served by a GOSP. The heater treaters would be replaced by a separator. As GOSPs are phased in, the well facilities would be reduced or eliminated, resulting in a decrease in pumper truck traffic. Maintenance activities would be re-directed to the GOSPs.

During daily operation of the Green River oil wells, produced oil and water from the wells may potentially be transported via surface pipeline to one of the existing or proposed GOSPs located within the MBPA. The oil and produced water would be separated at the GOSPs and routed to separate storage tanks. Oil would be sold directly from the GOSPs and transported to commercial points outside of the MBPA by tanker truck. Well site storage tanks, a VOC emissions source, and related tanker truck traffic would be eliminated at wells served by a GOSP.

Produced water from the Green River oil wells would be transported by pipeline to one of the proposed water treatment and injection facilities. Produced water not suitable for reinjection would be trucked to permitted salt water disposal (SWD) wells for disposal.

Crude oil produced from the Green River reservoir sands in the MBPA is known to be high in paraffin content, with a pour point of 95 degrees Fahrenheit (˚F), below which the oil solidifies. Consequently, flowlines and production tanks would be equipped with a closed-loop trace system that circulates heated ethylene glycol solution (antifreeze) to maintain crude oil in a fluid state.

2.3.6.1.2 Deep Gas Wells

Production equipment at deep gas wells would include a wellhead; one 400-bbl condensate/production tank; one 400-bbl produced water tank; storage tanks for methanol and motor oil; a gas meter; and a combination unit 2.0-MMscf/d separator and dehydrator, with an integral boiler (estimated at 750 thousand British Thermal Units (MBtu)/hr). Ancillary equipment on each of the well pads may include 150-gallon chemical storage drums.

Gathered natural gas produced from the deep gas wells would be flared for up to 30 days after initial well evaluation tests. If flaring is to exceed 30 days, Newfield would request approval from the appropriate regulatory authority (i.e., UDOGM or EPA). Following testing and during daily operation of the gas wells, gas from an individual well would first be separated from associated condensate and water at the well pad and then piped to one of the proposed or existing compressor stations. Once the produced gas is compressed and dehydrated at the proposed compressor stations, it would be carried via pipeline to the central gas processing plant where it would be prepared for delivery to a sales pipeline. Condensate from the deep gas wells would be sold and transported to commercial points outside of the MBPA by tanker truck. Produced water from the deep gas wells would be transported by pipeline to one of the proposed water treatment and injection facilities, where it would be treated and used in the Green River secondary oil recovery waterflood program or trucked to a SWD well for disposal.

2.3.6.1.3 Conversion of 40-acre Spaced Green River Oil Wells to Injection Wells

Waterflooding consists of pumping water into various isolated Green River Formation oil reservoirs to re-pressurize and displace the oil more efficiently than primary depletion alone. Newfield would use waterflooding technology on the majority (i.e., approximately 60-70 percent) of the proposed 40-acre surface and downhole spaced Green River wells after initial production. Oil well conversion to injection wells would occur after approximately 3 years of production.

During oil well conversion, oil production equipment (anchor, sucker rods, pump jacks, well head valves, flow lines, treater, water tank, and oil tanks) would be removed from the well pad. A packer would be installed on the end of the tubing and set no more than 100 feet above the top perforation. Pressure monitoring gauges would be installed on the wellhead and casing annulus to monitor the pressure at which water is injected and the casing pressure, respectively.

Water injection lines would be installed from the main pipeline to the individual wells to provide water. Injection wells would be equipped with flow meters and choke valves to regulate injected water volumes. After all water injection lines are installed, produced water would be injected into the oil-bearing formation.

2.3.6.2 Maintenance

Routine inspection and maintenance of project facilities within the MBPA would occur on a year-round basis or as ground and site conditions permit. New wells would typically be visited daily by a maintenance worker and 3 to 4 water trucks for approximately 2 to 3 weeks after completion, based on well performance.

When operationally feasible, meters at all producing wells would be equipped with remote telemetry monitoring systems. The system would monitor gas and water production rates, pipeline pressure, and separator pressure to determine if abnormal conditions exist. Control and monitoring of well production by remote telemetry would reduce the number of pumper visits based on well performance.

Project roads would be maintained to provide year-round access. Maintenance would correct excessive soil movement, rutting, holes, replacement of surfacing materials, clearing of sediment blocking ditches and culverts, and/or damage to cattle guards, gates, or fences. Should snow removal be necessary, roads would be cleared with a scraper and snow would be stored along the down gradient side to prevent runoff onto the road.

Road maintenance agreements and requirements would vary in the MBPA, based on the owner of the road. Under existing agreements between the BLM and the counties, Duchesne and Uintah Counties maintain segments of BLM roads in the MBPA. Counties would continue to maintain existing county roads. Newfield would be required to maintain access roads to the standards specified in their use authorization, and in accordance with BLM road standards established in the *Gold Book*. Dust control would be achieved by using water or other SMA-approved dust suppressants, such as magnesium carbonate.

2.3.6.2.1 Workovers and Recompletions

Each new well would likely require a workover during the first year of production. A workover rig is similar to a completion rig and performs a variety of maintenance procedures to keep the well operating efficiently. Workovers can include repairs to casing, tubing, rods, pumps, the wellhead, or the production formation itself (i.e., to increase or maintain production from downhole-producing zones or to re-complete a well in a new zone). These repairs generally occur during daylight hours and typically would require approximately 3 days. In some limited situations, workovers may require up to 10 days. In the case of a recompletion, where casings are worked on or valves and fittings would be replaced to stimulate production, all by-products would be stored in tanks and hauled from the location to an approved/permitted disposal site.

2.3.7 Final Reclamation and Abandonment

For the complete reclamation and weed control plan for this project, refer to **Appendix D**. A typical well life span varies from 20 to 30 years. Prior to reclamation of any well pad, pipeline or road, Newfield would file a Notice of Intent (NOI) to abandon with the BLM that details the proposed procedures. The BLM would then attach the appropriate surface rehabilitation COAs for the well pad and for the associated access road, pipeline, and ancillary facilities as appropriate,. During plugging and abandonment, all other surface equipment, including tanks, pumping unit, three-phase separator, and aboveground flow lines, gas system pipelines, and water pipelines, would be removed from the site. Buried pipelines would be purged and left in place. Wellbores would be plugged with cement to prevent fluid or pressure migration and to protect mineral and water resources. Wellheads would be removed, both the surface casing and production casing would be cut off below ground level, and an appropriate dry hole marker would be set in compliance with federal and State regulations and SMA direction. Backfilling, leveling, and recontouring would then be performed according to the appropriate SMA.

All abandoned roads, ROWs, compressor stations, GOSPs, and other surface facilities would be reclaimed to their original condition as near as practical and in compliance with the appropriate SMA. At the time of final abandonment, all surface equipment, including all surface pipelines, would be removed from the site. Cut and fill materials would be recontoured, and topsoil would be replaced on the surface above the former location to blend the site with its natural surroundings. These areas would then be seeded with an SMA-approved seed mixture. Follow-up survey and treatment of weeds and invasive plant species would be conducted until reclamation is deemed to be successful and/or complete.

On Federal lands, reclamation of surface disturbance associated with the proposed project would follow the *Green River District Reclamation Guidelines for Reclamation Plans* (BLM 2011a). Reclamation plans may be revised and finalized when a site-specific APD and/or ROW application is submitted to the BLM.

2.3.8 Water Requirements

The following section describes water needs for well drilling and completion, dust suppression, and waterflooding operations. Calculations in this document are based on a 42-gallon barrel.

During the early phases of the project, water would be used for drilling and completion purposes and obtained from existing permitted water supply sources (see **Table 2.3.8.3-1**). These sources would consist of both ground water from wells, surface withdrawals, and from Newfield’s proposed water collector well along the Green River. Withdrawals would be made from suppliers that hold existing water rights permits through the Utah Division of Water Rights. During the latter portions of the Project, the majority of project water needed would come from recycled produced water. Water volumes required for drilling, completion, dust suppression, and waterflooding would depend on the alternative selected.

Information on water requirements for drilling and completion activities is provided in **Table 2.3.8-1**.

TABLE 2.3.8-1
WATER REQUIREMENTS FOR WELL DRILLING AND COMPLETION, DUST SUPPRESSION, AND WATERFLOODING OPERATIONS UNDER ALTERNATIVE D

Activity/Phase	Number of Wells / Well Pads	Amount of Water Required per Well (acre-feet)	Total Water Use (acre-feet)	Annual Water Use (acre-feet)
Well Drilling and Completion[1]				
New Vertical Green River Oil Wells	750	0.9	675	42*
New Directional Green River Oil Wells	2,500	0.9	2,250	141*
New Vertical and Directional Deep Gas Wells	2,500	6.2	15,500	967*
Subtotal for the 16-year active well drilling and completion period	5,750	--	18,425	1,150*
Dust Suppression				
Construction of New Well Pads / Expansion of Existing Well Pads and Associated Roads and Pipeline/Utility Corridors	278	0.08[2]	22	1.4
Subtotal for the 16-year Active Well Drilling and Completion Period	**278**	**--**	**22**	**1.4**
Operation of New Well Pads / Expansion of Existing Well Pads and Associated Roads and Pipeline/Utility Corridors	278	0.13[3]	723 – 1,084	36[4]
Subtotal for the 20- to 30-Year Operational Period	**--**	**--**	723 – 1,084	36
Waterflooding Infrastructure and Operations				
Conversion of up to 750 injection wells	750	0.01[5]	54,760 – 82,140[6]	2,738

Activity/Phase	Number of Wells / Well Pads	Amount of Water Required per Well (acre-feet)	Total Water Use (acre-feet)	Annual Water Use (acre-feet)
TOTAL	--	--		

[1] Assumes a 16-year active well drilling and completion period.
[2] Approximately five water trucks (approximately 650-bbls or 0.08 acre-feet) would be needed for dust suppression per new or expanded well pad, access road, and pipeline/utility corridor during construction activities, for approximately 10 percent of the proposed project (i.e., 10 percent of the 2,783 expanded and new well pads).
[3] Approximately eight water truck (approximately 1000-bbls or 0.13 acre-feet) would be needed annually for dust suppression per new or expanded well pad, access road, and pipeline/utility corridor during project operation, for approximately 10 percent of the proposed project (i.e., facilities10 percent of the 2,783 expanded and new well pads).
[4] Calculated based on 36 acre-feet annually.
[5] Assumes 0.01 acre-feet of water per well daily.
[6] Calculated based on 2,738 acre-feet annually over the 10-year conversion period.
[*] Based on average annual water use.
Note: Summations may not total precisely due to rounding.

2.3.8.1 Drilling and Completions

Typically, 7,000-bbls (0.9 acre-feet) of water would be required to drill and complete a Green River well, and approximately 48,000-bbls (6.2 acre-feet) of water would be required to drill and complete a deep gas well. Water used during drilling and completion would be piped to water treatment and injection facilities. The total water use for drilling and completion of all wells could be up to 18,425 acre-feet.

2.3.8.2 Dust Suppression

Approximately 650 bbls (0.08 acre-feet) of fresh water would be needed for dust suppression per new well pad, associated access road, and pipeline/utility corridor for approximately 10 percent of the proposed wells during construction (i.e., for approximately 278 new or existing to be expanded well pads and their associated roads, pipeline/utility corridors, and other surface facilities). A total of approximately 1.4 acre-feet of water would be needed annually for dust suppression during construction activities under Alternative D.

In addition, approximately 1,000 bbls (0.13 acre-feet) of water would be needed annually for dust suppression per new or expanded well pad, associated access road, and pipeline/utility corridor during project operations, again for approximately 10 percent of the proposed project (i.e., for approximately 278 well pads and their associated roads, pipeline/utility corridors, and other surface facilities). Therefore, implementation of Alternative D would require approximately 36 acre-feet of water annually for dust abatement during project operations.

Water used for dust suppression would represent a small percentage of the total water needs for the proposed project. Dust abatement would be implemented using standard water trucks that hold approximately 130 bbls of water (0.016 acre-feet).

2.3.8.3 Waterflooding Infrastructure and Operations

Newfield would use waterflooding technology on all of the proposed 40-acre spaced Green River wells (i.e., approximately 750 wells) after about the first 3 years of production. A total of approximately 75 to 100 bpd, or approximately 0.01 acre-feet per day, of water would be required for each waterflood injection well. Newfield would convert approximately 750 of their proposed wells to injection wells, therefore requiring approximately 7.5 acre-feet of fresh and produced water per day for injection purposes. Based on the requirement of 7.5 acre-feet of water per day, the annual water requirement for waterflooding operations would be approximately 2,738 acre-feet. Under Alternative D, it is assumed Newfield would use 40 to 50% recycled water for waterflooding purposes (nearly all available recycled water).

Approximately half of the water for flooding operations could come from produced water that would be treated for injection, and the other half could be obtained from freshwater sources identified in **Table 2.3.8.3-1**. Fresh water for waterflooding and infrastructure and operations would come from sources identified in **Table 2.3.8.3-1** and Newfield's proposed water collector well**.**

TABLE 2.3.8.3-1
EXISTING WATER SUPPLY SOURCES FOR THE MONUMENT BUTTE PROJECT

Base Water Right	Segregated Water Right	Supplemental Group Number	Change Number	Filing Date	Source	Location	Annual volume (acre/ft.)	Use	Depletion
43-7478	None	217235	a11187	4/29/74	Underground Water Well	N 500 ft. W 110 ft. from SE cor, Sec 30, T2S, R2W; N 2,407 ft. W 200 ft. from SE cor Sec 30, T2S, R2W	225.0	Municipal	Historic
47-1358	None	None	t37916	6/26/63	Tributary to Pleasant Valley Wash	N 1,410 ft. E 1,450 ft. from W4 cor Sec 7, T4S R1W	99.0	Industrial: O&G Drilling	Historic
41-3530	47-1817	621892	a31022	2/6/06	Duchesne County Water Conservation District	S 1,087 ft. E 1020 ft. from N4 cor, Sec 15 T2N, R22E	690.0	Industrial: O&G Recovery	New
41-3530	47-1821	None	a31022a	10/29/09	Duchesne County Water Conservation District	S 413 ft. E 1225 ft. from N4 cor, Sec 27, T9S, R19E	2,210.0	Industrial: O&G Recovery	New
47-1802	None	225664	a34586	4/23/94	Green River Collector Well	S 413 ft. E 1225 ft. from N4 cor, Sec 27, T9S, R19E	941.1	Industrial: O&G Recovery	New
47-1804	None	225666	a34585	12/4/95	Green River Collector Well	S 413 ft. E 1225 ft. from N4 cor, Sec 27, T9S, R19E	941.1	Industrial: O&G Recovery	New
Total	**--**	**--**	**--**	**--**	**--**	**--**	**5,106.2**	**--**	**--**

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2.3.8.4 Water Collection Stations

Up to approximately 1 acre of temporary surface disturbance would occur within the floodplain for construction of the water source well. The water source well would extend to a depth of approximately 100 feet below the surface and would be developed using conventional drilling methods. An example diagram of a water source well (i.e., depicting one well with five laterals) and the associated water processing station from Newfield's existing water collection station in the SE1/4 of Section 22 and NE ¼ of Section 27, T9N:R19E is included in **Figure 2.2.8.3-1 (Attachment 1)**. Water quality and quantity would be measured at the proposed water collection station both prior to construction and drilling and within three months following operation. Results would be provided to the BLM, EPA, Bureau of Land Management (BLM), Utah Division of Oil Gas and Mining (UDOGM), the Utah Division of Water Quality (UDWQ) Groundwater Protection Section, and the UDWQ Watershed Management Section, and the Operator.

Each lateral would require a temporary pad approximately 100 feet by 100 feet in size (0.2 acre) to drill the hole and to install the pump. Following successful reclamation, surface disturbance within the floodplain would be limited to the maintenance hole cover on each well and the area immediately surrounding the manhole. The water source well would be equipped with steel casing between 10 to 14 inches in diameter. This casing would include sections of stainless steel screening that would allow groundwater to move from the surrounding alluvial aquifer into the wellbore. The screen opening typically would be no larger than 0.1 inch. The well casing would terminate 1 foot below the ground surface. The top of the casing would be capped with a bolt-down lid. A manhole structure and manhole lid also may be placed around the well casing with the lid flush to the ground surface. The area adjacent to and surrounding the manhole would be graded to the top of the manhole and seeded with a native, site-specific seed mix to blend with the surrounding areas.

The water source well would contain a submersible pump, motor, and electric cable. The pump and motor would be sealed in casing to prevent potential leaks of petroleum products (i.e., lube oil). The pump would be connected to a 6- to 8-inch outer diameter pipe, known as a carrier pipe, which would convey the pumped water from the water source well to the water processing station on the same side of the Green River. This carrier piping would be buried 5 feet bgs to prevent freezing and to avoid long-term surface disturbance within the floodplain. Installation of the water source well would occur during the low-flow season of the Green River (fall/winter).

The water processing station would require an area of 200 feet by 150 feet (0.7 acre) of surface disturbance, located adjacent to but outside of the Green River 100-year floodplain. Power for the water processing station would be provided by a 300- to 600-hp generator that would be located within a building. Onsite power generation would utilize either produced natural gas or NGL as a fuel source to power the generator associated with the processing station. The generator would power the fresh water well pump and booster pump that would transport the water to each of the injection wells. The water processing station would include a hydrocyclone system to remove solids from the waterflood system for injection. A hydrocyclone is a stationary device that uses centrifugal force to separate solids such as fine sand from the water. This system would precipitate solids from the water and would have a combined capacity of 20,000 bbls per day (bpd). The water processing station would likely be located on private land, and therefore would be subject to landowner negotiations and site-specific conditions. Therefore, a conceptual location for the water collector station is not identified in this EIS.

The water processing station would include a 40-foot by 40-foot parking lot and a building approximately 30 feet long by 25 feet wide with walls approximately 10 feet high. The parking lot would be graded and graveled. The building would be constructed of either cinder block or metal siding finished in an earth tone. The roof on the building would be pitched, of metal construction, and would be finished in an earth tone. If noise attenuation of the generator does not reduce noise to 45 decibels (dB), critical-grade mufflers would be installed to further reduce noise levels. Tree and shrub species recommended by the surface owner would be planted along the sides of the building facing the Green River to minimize the visibility of the building from the Green River. In addition, Newfield would develop a landscaping plan describing plant spacing and irrigation and maintenance requirements.

Water from the fresh water collection areas would be either pumped into a wet well (cistern) located beneath the building or piped directly to the booster pumps for distribution via buried pipelines to the well field. Some excess water may occur during initial flow back immediately after drilling the well. All water is groundwater and no chemicals filtering or treatment of the water occurs. The volume of water is small and this occurs infrequently. Once connected, 100% of the water produced by the well is contained within infrastructure, and no discharges occur.

A network of buried, high pressure water pipelines would supply both fresh water and treated water from the central water processing station to the injection wells. These water pipelines would be buried approximately 4 to 5 feet deep within the same ROWs proposed for roads and other pipelines. Approximately 8 miles of 6-inch steel trunk lines and 4 miles of 3-inch steel lateral lines would be constructed to transport water from the central water processing facility to the injection wells. The injection wells would be equipped with flow meters and choke valves to regulate injected water volumes. Water pipelines would be from 4 to 8 inches in diameter and would be constructed from steel and/or polypropylene. These water pipelines would be buried to prevent freezing and would be installed in conjunction with (alongside) the high-pressure gas gathering pipelines, where possible.

2.3.8.5 Water Depletion and Previous USFWS Consultations

Newfield currently has secured water rights for up to 5,106 acre-feet per year from the water supply sources identified in **Table 2.3.8.3-1**. Water from these sources will be used for drilling, completion, dust suppression, and waterflood operations. Of this volume for existing water rights, 324 acre-feet are from water sources considered historic depletions under the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (USFWS 1987). Section 7 consultation was completed for all historic depletions in 1993 (USFWS 1993). As part of this consultation, it was determined that historic depletions, regardless of size, do not pay a depletion fee to the Recovery Program.

In addition, three consultations have been completed for water depletions associated with oil and gas development projects in the MBPA. Currently, a total annual volume of 3,328 acre-feet has been authorized through these consultations (see **Table 2.3.8.5-1**). Water used under these previous consultations, plus the historic water rights, makes a total of 3,652 acre-feet of water available for this project that have gone through the Section 7 consultation process. Any additional water needed for the proposed project (e.g., water from (WR 41-3530; WR 47-1802; WR 47-1804 and the proposed water collector well) would require additional consultation.

TABLE 2.3.8.5-1
PREVIOUS USFWS CONSULTATIONS FOR WATER USAGE IN THE MBPA

Project	Biological Opinion	Date	Consulted Water Volume	Depletion Payment
Final Formal Section 7 Consultation for Castle Peak Eightmile Flat Oil and Gas Expansion Project	6-UT-05-012 05-0600	7/6/05	2,081 acre-feet	$33,920.30
Amendment to Formal Section 7 Consultation for Castle Peak Eightmile Flat Oil and Gas Expansion Project Re: 6-UT-F-05-F012	FWS/R6	4/11/06	819 acre-feet	$13,652.73
Final Biological Opinion for Newfield's 20-acre Infill Development Project	06E23000-2012-F-0024 6-UT-12-F-002	1/20/12	428 acre-feet	$8,221.88
Total	**--**	**--**	**3,328 acre-feet**	**$55,794.91**

2.3.9 Produced Water Disposal

Under Alternative D, up to 13 new water treatment and injection facilities and a new water disposal well would be constructed. In addition, up to six pump stations would be constructed under Alternative D.

If required, the water disposal well would be drilled in the MBPA on an existing well pad or using an existing well boring. The new disposal well would have an average capacity of 4,000 BWPD. Although future water production is difficult to predict because of variable water saturation conditions as the oil and gas formations are produced and depleted, it is estimated for purposes of analysis in this EIS that Newfield would use 40 to 50% recycled water for waterflooding purposes (nearly all available recycled water).

Produced water from newly completed wells may be temporarily disposed of within lined reserve pits or storage tanks for a period not to exceed 360 days after initial production on State or private land (per UDOGM regulations), and 90 days on BLM-administered lands (per *Onshore Oil and Gas Order No. 7*). On BLM-administered lands, pits may be reused if additional wells are drilled from the same well pad within a one-year time frame.

Additional produced water disposal wells would likely be drilled in the MBPA on existing well pads, or existing wellbores would be converted from deep gas production to disposal operations to minimize additional surface disturbance. The number of produced water disposal wells would depend upon the ability to obtain the necessary permits through the appropriate permitting authority and the number of additional wells drilled under Alternative D. Injection into disposal wells is Newfield's preferred method of produced water disposal.

Underground injection wells used in conjunction with oil and gas production are referred to as Class II wells under the EPA Underground Injection Control (UIC) program. Class II wells can be used either for pressure maintenance to increase the efficiency of the recovery of oil and gas, or can be used for the disposal of liquid waste generated by oil and gas production operations that meets the definition of exploration and production waste exempt under the Resource Conservation and Recovery Act (RCRA), Subpart D (mainly produced water). In December of 2012, Newfield received an approved UIC Area Permit from the EPA for the MBPA (Area UIC Permit No. UT22197-0000). Within the MBPA, Newfield currently operates 517 UIC wells under UDOGM jurisdiction, and 538 UIC wells under EPA jurisdiction, all of which support their secondary recovery program. Newfield operates one SWD well in the MBPA (i.e., the GMBU Pariette 4-7-9-19).

Permitting of Class II wells is regulated in Utah by UDOGM and by the EPA for Indian trust lands[5]. The permit process requires agency review of the application and a 15- to 30-day public comment period upon publication of notice of a draft permit. If there are no protests or objections to a pending application, it would be approved administratively.

Up to three water treatment and injection facilities would be constructed. The proposed water treatment facilities would be used for recycling of produced water that either would be co-mingled with fresh water and piped for waterflood injection wells or trucked from the facility to be used at subsequent wells for completion activities. Conceptual locations for water treatment and injection facilities have been illustrated on the Alternative D map (see **Figure 2-4 – Attachment 1).**

2.3.10 Hazardous Materials and Solid Waste

A variety of chemicals, including lubricants, paints, and additives, are used to drill, complete, and operate a well. Some of these substances may contain constituents that are hazardous. Hazardous materials can include some greases or lubricants, solvents, acids, paint, and herbicides, among others. These materials would not be stored at well locations, although they may be kept in limited quantities on drilling sites and at production facilities for short periods of time.

None of the chemicals that would be used during drilling, completion, or production operations meet the criteria for being an acutely hazardous material/substance or meet the quantities criteria per the BLM *Instruction Memorandum No. 93-344*. Most wastes that would be generated at project locations are excluded from regulation by the RCRA under the exploration and production exemption in Subtitle C (40 CFR 261.4[b][5]) and are considered to be solid wastes. These wastes include those generated at the wellhead, through the production stream, and through the inlet of the gas plant. Exempt wastes include produced water, production fluids such as drilling mud or well stimulation flowback, and crude oil impacted soils.

Any spills of oil, gas, salt water, or other such fluids would be cleaned up and removed to an approved disposal site. Spills of at least 10 barrels in non-sensitive areas would be reported to the AO in a written

[5] The State of Utah has primacy for the UIC program outside of Indian Country. The US EPA retains primacy for UIC in Indian Country under the Safe Drinking Water Act. In the MBPA, the EPA Region 8 office administers Range 17E–19E.

report and to other appropriate authorities. Major undesirable events of 100 barrels or more must be reported to the AO within a maximum of 24 hours; however, if the spill is entirely contained within the facility firewall, it may be reported only in writing pursuant to Section III of NTL-3A. Any spill which occurs in a sensitive area, regardless of the volume involved, must be reported within 24 hours to the AO.

Drilling and production operations would require preparation of a Spill Prevention Containment and Control (SPCC) plan that outlines the methodology to be used in the event of a spill. The SPCC plan describes spill control, reporting, and cleanup procedures to prevent impacts to surface and subsurface waters. A copy of the drilling company's SPCC plan would be kept on site during drilling operations. All produced liquid hydrocarbons would be stored in tanks surrounded by a secondary containment berm of sufficient capacity to contain the entire capacity of the largest single container with sufficient freeboard for precipitation. All loading lines and valves would be placed inside the berm surrounding the tank or would use catchment basins to contain spills. The tanks would be emptied as necessary to prevent overflow, and the liquids transported to market via trucks and/or pipelines.

Portable toilets and trash containers would be located on active construction sites throughout the MBPA. A commercial supplier would install and maintain portable toilets and equipment and would be responsible for removing sanitary waste. Sanitary waste facilities (i.e., toilet holding tanks) would be regularly pumped and their contents disposed of at approved sewage disposal facilities in Carbon, Duchesne, and/or Uintah Counties, in accordance with applicable rules and regulations regarding sewage treatment and disposal.

Accumulated trash and nonflammable waste materials would be hauled to an approved landfill once a week or as often as necessary. All debris and waste materials not contained in the trash containers would be cleaned up, removed from the construction ROW or well pad, and disposed of at an approved landfill. Sanitary waste equipment and trash bins would be removed from the MBPA upon completion of the construction of well pads, access roads, and other surface facilities, and following drilling and completion operations at well pads.

2.3.11 Adaptive Management Strategy for Potential Adverse Ozone Formation

Ozone concentrations in the Uinta Basin have been found to be exceeding National Ambient Air Quality Standards (NAAQS) during periodic winter inversion events. A comprehensive understanding of the chemical pathways, analytical methodologies, and demonstrable control technologies and methods has been lacking to allow for a scientifically based examination of this issue in recent NEPA documents relating to oil and gas production in the Uinta Basin. To address the uncertainty relating to this, BLM has been including adaptive management requirements in both recent and current NEPA documents relating to significant oil and gas development in the Basin. One of the components of these adaptive management prescriptions is the commitment to apply enhanced mitigation for ozone when an exceedance of the ozone NAAQS has been measured and recognized based on criteria in the Clean Air Act that defines how NAAQS determinations are made (40 CFR Part 50). Based on recent studies, BLM believes this adaptive management requirement for enhanced mitigation has been triggered, and that tentative control determinations can be made at this time as an initial start in controlling and preventing winter ozone formation. The control measures identified in **Section 2.3.14.1** reflect the best available air pollution control technology as applied to oil and gas exploration and development, and in some cases are more restrictive and achieve a greater level of control than required under current Clean Air Act and State of Utah regulations.

Over the past 3 years, significant research had been conducted in the Uinta Basin to further the understanding of winter ozone formation (USU EDL 2011). Current studies indicate that high levels of VOC are found throughout the Uinta Basin, which may be significantly contributing to high winter ozone episodes. The winter ozone study is still ongoing. BLM, in consultation with the Utah Department of Environmental Quality - Division of Air Quality (UDEQ-DAQ) and the EPA, is currently in the process of developing a list of enhanced seasonal pollution control measures and work practices specifically aimed at reducing the emissions of VOCs which form winter ozone. These control measures and work practices will be required for all operations approved under this NEPA action.

It is recognized in this adaptive management prescription that additional research and analysis needs to be conducted in the Uinta Basin to more fully understand the mechanics of winter ozone formation, and that specific control and work practice recommendations may change over time. To address the continued scientific uncertainty on this issue, BLM will continue to include an adaptive management requirement in NEPA documents for oil and gas developments in the Uinta Basin. Once a basin-wide control plan is developed and approved by UDEQ-DAQ and/or EPA, BLM will review these control measures and may add, delete, or otherwise modify these requirements to conform to the requirements or recommendations of a regulatory basin-wide management plan. These adaptive management modifications will be applicable to this NEPA action.

2.3.12 Workforce Requirements

The active workforce needed to develop Alternative D is estimated in **Table 2.3.12-1**.

TABLE 2.3.12-1
ESTIMATED WORKFORCE REQUIREMENTS UNDER ALTERNATIVE D

Work Category	Time Requirements	Number of Facilities/ Miles	Personnel Required (No. per day)	Workdays for Project	Average Workdays per Year	Average Workers per Day[1]
Construction and Installation						
Access Road	4 days/mile	544	8	17,408	1,088	5
Well Pad (new and expansion of existing)	3 days/site	2,783	8	66,792	4,174	17
Pipelines	10 days/mile	544	10	54,400	3,400	14
Drilling and Casing	4 days/well	5,750	8	184,000	11,500	48
Well Completion	4 days/well	5,750	20	460,000	28,750	120
Well Production	10 days/well	5,750	16	920,000	57,500	240

Work Category	Time Requirements	Number of Facilities/ Miles	Personnel Required (No. per day)	Workdays for Project	Average Workdays per Year	Average Workers per Day[1]
Central Facilities	45 days/site	57	20	51,300	3,206	13
Total				**1,753,900**	**109,618**	**457**
Operation and Maintenance						
Road/Well Pad Maintenance	120 days/year	N/A	3	16,560	360	2
Pumpers	260 days/year	N/A	36	430,560	9,360	39
Office	260 days/year	N/A	3	47,840	1,040	4
Well Workover	5 days/well	30 per year	2	6,900	150	1
Total				**501,860**	**10,910**	**45**
Reclamation and Abandonment[4]						
Well Pads	3 days/well pad	2,783	4	33,396	N/A	--
Roads and Pipelines	4 day/mile	544	4	8,704	N/A	--
Central Facilities	30 day/facility	57	16	27,360	N/A	--
Total				**69,460**	**--**	**--**

1 Average workdays per year divided by an assumed 240 days in a work year.
2 Based on a 16-year construction schedule.
3 Based on a 46-year production and operation schedule.
4 Includes interim reclamation.

2.3.13 Management Actions

Table 2.3.13-1 provides a description of the regulatory requirements and standard operating practices that would be applied under Alternative D. The table is subdivided by requirements and commitments specific to pre-drilling, construction, drilling, completion, production, interim reclamation and maintenance, and final reclamation and abandonment. The measures listed under each of these stages are then further subdivided into a list of regulatory requirements.

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TABLE 2.3.13-1
REGULATORY REQUIREMENTS AND STANDARD OPERATING PRACTICES

Implementing Authority/ Regulation/Statute	Description of Requirement
Pre-drilling	
U.S. Environmental Protection Agency (EPA) Spill Prevention Control and Countermeasures (SPCC) Regulations (40 CFR 112)	▪ Newfield would implement and adhere to SPCC plans and provide personnel with an orientation to ensure they are aware of the potential effects of accidental spills, as well as the appropriate recourse if a spill does occur (40 CFR 112). Newfield currently adheres to the EPA SPCC regulations through development of SPCC plans, ongoing training and routine inspections of all existing and new well sites/facilities that are subject to the rule. Newfield will develop Facility Response Plans (FRP) for each Gas Oil Separation Plant (GOSP) as required by 40 CFR 112.20 & 112.21.
Utah Department of Environmental Quality-Division of Water Quality (UDEQ-DWQ) and U.S. Army Corps of Engineers (USACE), Section 404, Federal Water Pollution Control Act (Clean Water Act) (33 USC 1251, et seq.)	▪ Any disturbances to wetlands and/or waters of the United States would be authorized by the UDEQ-DWQ, in cooperation with the USACE Office. Section 404 permits would be secured as necessary prior to disturbance.
Occupational Safety and Health Administration (OSHA) Regulations (29 CFR 1910.1200)	▪ Newfield would institute its own internal Hazard Communication Program (HCP) for its personnel and require that subcontractor programs be in compliance with Newfield's HCP. In addition, a Material Safety Data Sheet (MSDS) for every chemical or hazardous material brought on-site would be kept on-site or on file at Newfield's Field Office (FO).
BLM/U.S. Forest Service (USFS) Surface Operating Standards for Oil and Gas Exploration and Development ("Gold Book"), Chapter 4	▪ Existing topography would be used to screen roads, pipeline corridors, drill rigs, wells, and production facilities from view where practical. Newfield would paint all aboveground production facilities with approved colors (e.g. specified standard environmental colors) to blend with adjacent terrain, except for structures that require safety coloration in accordance with OSHA requirements.
Construction	
BLM, Onshore Oil and Gas Order No. 1 (43 CFR 3160)	▪ On federal land, operators would prepare and submit individual comprehensive drill-site design plans for BLM approval. These plans would show the drill location layout over the existing topography; dimensions of the locations, volumes, and cross sections of cut and fill; location and dimensions of reserve pits; existing drainage patterns; and access road egress and ingress. Plans and shapefiles would be submitted and approved prior to initiation of construction. ▪ Well pads and associated roads and pipelines would be located to avoid or minimize impacts in areas of important ecological value (e.g., sensitive species habitats and wetland/riparian areas).

Implementing Authority/ Regulation/Statute	Description of Requirement
BLM Manual 9113—Roads; BLM/USFS Surface Operating Standards for Oil and Gas Exploration and Development ("Gold Book"), Chapter 4	▪ Roads on BLM surface would be constructed as described in BLM Manual 9113. Running surfaces of roads may be graveled if the road base does not already contain sufficient aggregate. ▪ Existing roads would be used when the alignment is acceptable for the proposed use. Generally, roads would be required to follow natural contours and provide visual screening by constructing curves, etc. All roads on BLM-managed lands would be reclaimed to BLM standards.
BLM Manual, Section 8400 (43 CFR 2802); BLM/USFS Surface Operating Standards for Oil and Gas Exploration and Development ("Gold Book"), Chapter 4	▪ Pipeline rights-of-way (ROWs) would be located within existing ROWs whenever possible. Aboveground facilities that do not require safety coloration would be painted with appropriate non-reflective standard environmental colors, as specified by the authorized officer (AO). Topographic screening, vegetation manipulation, project scheduling, and traffic-control procedures may all be employed as specified by the AO to further reduce visual impacts.
BLM Regulations (43 CFR 2802) regarding applications for ROWs; BLM/USFS Surface Operating Standards for Oil and Gas Exploration and Development ("Gold Book"), Chapter 4	▪ Salvage and subsequent replacement of topsoil would occur for surface-disturbing activities wherever practical.
USACE, Section 404, Federal Water Pollution Control Act (Clean Water Act) (33 USC 1251, et seq.)	▪ Where disturbance of regulated U.S. waters cannot be avoided, Newfield would obtain CWA Section 404 permits as required. Operations would be conducted in conformance with the requirements of the approved permits.
BLM Regulations (36 CFR 800) implementing Section 106; National Historic Preservation Act (NHPA) (16 USC 470, et seq.)	▪ If cultural resources are located within frozen soils or sediments that preclude the possibility of adequately recording or evaluating the find, construction would cease and the site would be protected for the duration of frozen soil conditions. Recordation, evaluation, and recommendations concerning further management would be made to the AO following natural thaw. The AO would consult with the affected parties, and construction would resume once management of the threatened site has been finalized and a Notice to Proceed has been issued.
BLM Manual 9112 (Bridges and Major Culverts) and Manual 9113 (Roads); BLM/USFS Surface Operating Standards for Oil and Gas Exploration and Development ("Gold Book"), Chapter 4	▪ Streams/channels crossed by roads would have culverts installed at all appropriate locations as specified in BLM Manuals 9112 and 9113. Low-water crossings can be effectively accomplished by dipping the road down to the bed of the drainage.
BLM/USFS Surface Operating Standards for Oil and Gas Exploration and Development ("Gold Book"), Chapter 4	▪ Prudent use of erosion-control measures, including diversion terraces, riprap, matting, temporary sediment traps, and water bars, would be employed by Newfield as necessary and appropriate to control surface runoff generated at well pads. If necessary, Newfield would treat diverted water in detention ponds prior to release to meet applicable state or federal standards. ▪ Reserve pits would be constructed to ensure protection of surface water and groundwater. All reserve pits would be lined using liners of at least 16-mil thickness. Additional felt padding would be used as necessary, at the discretion of the AO.

Implementing Authority/ Regulation/Statute	Description of Requirement
	▪ Appropriate erosion control and revegetation measures would be employed. Grading and landscaping would be used to minimize slopes, and slope stabilizers would be installed on disturbed slopes in areas with unstable soils where seeding alone may not adequately control erosion. Erosion control efforts would be monitored by Newfield, and necessary modifications would be made to control erosion. ▪ Diversion structures, mulching, and terracing would be installed as needed to minimize erosion. In-stream protection structures (e.g., drop structures) in drainages crossed by a pipeline would be installed as appropriate to prevent erosion. ▪ Newfield would incorporate proper containment of condensate and produced water in tanks and drilling fluids in reserve pits and would locate staging areas for storage of equipment away from drainages to prevent potential contaminants from entering surface waters.
Drilling	
Utah Department of Transportation (UDOT) Standards and Specifications	▪ Load limits would be observed at all times to prevent damage to existing road surfaces. Special arrangements would be made with UDOT to transport oversize loads to the Project Area.
BLM/USFS Surface Operating Standards for Oil and Gas Exploration and Development ("Gold Book") Chapter 4 & 5; BLM Notice to Lessees 3-A (NTL 3-A); BLM WO Instruction Memorandum 99-061 Onsite Bioremediation of Exploration and Production Wastes or Spills of Crude Oil – Development of State Office Level Policies	▪ Any accidental soil contamination by spills of petroleum products or other materials would be reported to the appropriate authorities and cleaned up by Newfield. The soil would be disposed of or remediated according to applicable rules. Spills of at least 10 barrels in non-sensitive areas would be reported to the BLM AO in a written report and to other appropriate authorities. Major undesirable events of 100 barrels or more must be reported to the AO within a maximum of 24 hours; however, if the event is entirely contained within the facility firewall, it may be reported only in writing pursuant to Section III of NTL-3A. Any spill which occurs in a sensitive area, regardless of the volume involved, must be reported to the AO within 24 hours.
BLM/USFS Surface Operating Standards for Oil and Gas Exploration and Development ("Gold Book") Chapters 4 and 5; WO-IM-2013-033 Fluid Minerals Operations – Reducing Preventable Causes of Direct Wildlife Mortality; U.S. Migratory Bird Treaty Act (16 USC 703-712)	▪ Pits would be fenced as specified in individual authorizations. Any pit containing hazardous fluids would be maintained in a manner that would prevent migratory bird mortality. ▪ After cessation of drilling and completion operations, any visible or measurable layer of oil must be removed from the surface of the reserve pit, and the pit must be kept free of oil. ▪ Pits must be free of oil and other liquid and solid wastes prior to filling. Pit liners must not be breached (cut) or filled (squeezed) while still containing fluids. The pit liner must be removed to the solids level or treated to prevent its reemergence to the surface or to prevent its interference with long-term successful revegetation. ▪ Closed-loop drilling would be used to protect natural water courses and groundwater from contamination.
BLM COA attached to approved Application for Permit to Drill (APD)	▪ If reserve pit leakage is detected, then discharge into the pit would cease as directed by the BLM until the leakage is corrected.
Utah Division of Water Rights (Utah Administrative Code, Title 73)	▪ All water used in association with this project would be obtained from sources approved by the Utah State Engineer's Office.

Implementing Authority/ Regulation/Statute	Description of Requirement
Regulations (40 CFR 335) implementing Title III, Superfund Amendments and Reauthorization Act of 1986 (SARA) (42 USC 103)	▪ Chemicals would be inventoried and reported by Newfield in accordance with SARA Title III. If quantities exceeding the threshold planning quantity are to be produced or stored at any time within the Project Area, Newfield would submit appropriate Section 311 and 312 forms at the required times to the State Emergency Response Commission, Local Emergency Planning Committees, and the local fire departments.
EPA Resource Conservation and Recovery Act of 1976 (42 USC 6901, et seq.), DOT (49 CFR 177)	▪ Newfield would transport and/or dispose of any hazardous wastes as defined by the EPA RCRA, as amended, in accordance with all applicable federal, state, and local regulations.
Completion	
BLM Onshore Oil and Gas Order No. 2 (43 CFR 3163 and 3165)	▪ Newfield would case and cement all oil and gas wells to protect subsurface mineral and usable water zones. The BLM will require an operator to conduct cement bond log surveys, or other tests to verify cement adequacy.
BLM/USFS Surface Operating Standards for Oil and Gas Exploration and Development ("Gold Book"), Chapter 6; and Onshore Oil and Gas Order No. 1 (43 CFR 3160)	▪ Wells that have completed their intended purpose would be properly abandoned and plugged according to regulations governing plugging and abandonment identified by the BLM and/or UDOGM for State and private mineral estate.
BLM COA for APD (for wells/reserve pits located on BLM lands), and UDOGM (Utah Administrative Code R649-3-16) (for wells/reserve pits located on State and private lands)	▪ Following drilling and completion of the well, produced water will be removed within 90 days from the reserve pit, which will be closed within 6 months (BLM) and recontoured within 180 days (UDOGM), unless permission is granted by the BLM and/or UDOGM for a longer period. The pit contents must meet the UDOGM’s cleanup levels (Environmental Handbook, January 1996) or background levels prior to burial. The contents may require treatment to reduce mobility and/or toxicity to meet cleanup levels. The alternative to meeting cleanup levels would be transporting material to an approved disposal facility. BLM would generally defer to UDOGM’s preference, which would be for materials to remain on site if possible.
Production and Maintenance	
BLM Onshore Oil and Gas Order No. 7 (43 CFR 3160)	▪ Produced water from oil and gas operations would be disposed of in accordance with the requirements of Onshore Oil and Gas Order No. 7.
BLM/USFS Surface Operating Standards for Oil and Gas Exploration and Development ("Gold Book"), Chapter 6; and Onshore Oil and Gas Order No. 1 (43 CFR 3152)	▪ At producing wells, Newfield would reduce slopes to original contours (not to exceed 3:1 slopes where feasible). Areas not used for production purposes would be reclaimed, blended into the surrounding terrain, and reseeded, and installed with erosion control measures. These erosion control measures may be necessary after slope reduction. Mulching, erosion control measures, and fertilization may be necessary to achieve acceptable stabilization.
EPA SPCC Regulations (40 CFR 112)	▪ All storage tank batteries, treaters, dehydrators, and other production facilities that have the potential to leak or spill any oil, glycol, or other fluid that may constitute a hazard to public health or safety would be

Implementing Authority/ Regulation/Statute	Description of Requirement
	contained within the pad that would be surrounded by a berm along its entire perimeter. The berm would function as an appropriate containment and/or diversionary structure that would be constructed to prevent discharges from a primary containment system from draining, infiltrating, or otherwise escaping to ground or surface waters prior to completion of cleanup.
BLM Notice to Lessees 3-A (NTL 3-A)	▪ Notice of any spill or leakage (as defined in the BLM Notice to Lessees (NTL) 3A) would be immediately reported by Newfield to the AO. as well as to other appropriate federal and state officials as required by law. Oral notice would be given as soon as possible but within no more than 24 hours, and those oral notices would be confirmed in writing within 72 hours of any such occurrence.
EPA	▪ Newfield would obtain all necessary air quality permits from the EPA to construct and operate facilities.
Utah Department of Environmental Quality-Division of Air Quality (UDEQ-DAQ)	▪ Newfield would obtain all necessary air quality permits from UDEQ-DAQ to construct and operate facilities.
Final Reclamation and Abandonment	
BLM/USFS Surface Operating Standards for Oil and Gas Exploration and Development ("Gold Book"), Chapter 6; Onshore Oil and Gas Order No. 1 (43 CFR 3160)	▪ Abandoned sites would be reclaimed in accordance with the approved APD and the Subsequent Report of Abandonment (Sundry) process. Once successful reclamation has been achieved, Newfield would submit a Final Abandonment Notice (FAN) for approval by the AO prior to bond release.
BLM/USFS Surface Operating Standards for Oil and Gas Exploration and Development ("Gold Book"), Chapter 3	▪ All disturbances would be managed and reclaimed to minimize runoff from the well pads or other facilities until the area is stabilized.
BLM/USFS Surface Operating Standards for Oil and Gas Exploration and Development ("Gold Book"), Chapter 6; Onshore Oil and Gas Order No. 1 (43 CFR 3160)	▪ All excavations and pits would be closed by backfilling and contouring to conform to surrounding terrain. The Surface Use Plan of Operations (SUPO) would outline objectives for successful reclamation of well pads and other facilities, including soil stabilization, plant community composition, and desired vegetation density and diversity.
Common to All Project Phases	
Section 7(a) of the Endangered Species Act of 1973 (ESA), as amended	▪ Section 7(a) of the ESA requires federal agencies to evaluate their actions with respect to any species that is proposed or listed as endangered or threatened, and with respect to its critical habitat, if any has been designated. Regulations implementing this interagency cooperation provision of the ESA are codified at 50 CFR 402. Section 7(a)(2) requires federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of a federally listed species, or result in the adverse modification or destruction of its critical habitat. Section 7 Consultation would be conducted as necessary.
BLM Regulations (36 CFR 800) implementing Section 106, NHPA (16 USC 470, et seq.)	▪ Newfield would conduct all operations in conformance with Section 106 regulations (36 CFR 800) of the NHPA, as amended.

Implementing Authority/ Regulation/Statute	Description of Requirement
BLM Handbook (H-8270-1), General Procedural Guidance for Paleontological Resource Management	▪ Newfield would conduct all operations in conformance with BLM Handbook (H-8270-1).
BLM Handbook 9011-1, Exec Order 13112, Carlson-Foley 1968, and the Plant Protection Act of 2000, Public Law 106-224, and Fed Noxious Weed Act of 1974 as amended	▪ Newfield would obtain a Pesticide Use Proposal (PUP) prior to applying herbicides or pesticides. Newfield would treat project-related noxious weeds as required by all applicable regulations.
Clean Air Act (CAA), as amended, and the Federal Land Policy and Management Act (FLPMA)	▪ Newfield would conduct an annual emissions inventory and compare the inventory to the emissions estimates contained in this EIS. The inventory would be conducted annually for the life of the project (LOP) until the EPA/UDEQ/BLM develop an approved basin-wide control plan covering oil and gas development in the Uinta Basin. ▪ Regional photochemical modeling would be conducted that includes emissions for the selected alternative within one year of the ROD for this project or within one year of the BLM Air Resources Management Strategy (ARMS) modeling platform becoming available, whichever occurs first. If modeled impacts show that the National Ambient Air Quality Standards (NAAQS) or applicable thresholds for air quality related values may be exceeded, BLM will require additional mitigation measures within BLM's authority to prevent exceedances (for example requiring Newfield to implement an ozone mitigation contingency plan as described below). ▪ As needed, the BLM, with input from UDEQ-DAQ and EPA as appropriate, will refine the NOx and volatile organic compound (VOC) emissions inventory. The BLM, in coordination with UDEQ-DAQ and EPA as appropriate, will ensure that new modeling includes feasible best available control technology (BACT) requirements and a sensitivity analysis to determine appropriate reductions in ozone precursor emissions. The BLM, in coordination with UDEQ-DAQ and EPA as appropriate, will evaluate the modeling results. ▪ As soon as possible, and if needed following evaluation of the modeling results, the BLM, in coordination with UDEQ-DAQ and EPA as appropriate, will use their respective authorities to implement emission control strategies and/or operating limitations necessary to ensure compliance with applicable ambient air quality standards for ozone. Absent an effective technology to implement, reductions in the pace of development may be used to ensure ambient air quality standards are met. ▪ Newfield would implement project-specific enhanced mitigation measures to address winter ozone formation that includes the following: o FLIR/AVO inspections of pneumatic devices, pumps, tanks, and fugitives at least annually during January to March. o Perform regular maintenance on emitting devices and properly operate and maintain

Implementing Authority/ Regulation/Statute	Description of Requirement
	existing installed control equipment o Provide ozone training for operations personnel prior to the ozone season. o Implement work practices during the winter ozone period to reduce potential emissions, including charging desiccant dehydration units prior to the winter ozone period, reducing glycol dehydration circulation rates, minimizing blow-down actions, reducing the number of failed compressor startups, reducing compressor startups by performing maintenance during scheduled shutdowns, delaying optional activities that could cause emissions, and taking extra care to ensure maintenance and operation of equipment during winter ozone alert days. o The BLM may add, delete, or otherwise modify the enhanced mitigation measures to conform to the requirements or recommendations of a regulatory basin-wide management plan. ▪ The BLM will work with the appropriate regulatory agency to ensure monitoring and enforcement of mitigation measures occurs.
BLM MOU WO-230-2010-04, MOU between the BLM and the USFWS to Promote the Conservation of Migratory Birds	▪ BLM shall implement the MOU to the extent permitted by law and in harmony with agency missions, subject to the availability of appropriations and budgetary limits. At the project level, BLM will evaluate the effects of agency actions on migratory birds during the NEPA process, if any, and identify where take reasonably attributable to agency actions may have a measurably negative effect on migratory bird populations, focusing first on species of concern, priority habitats, and key risk factors. In such situations, BLM will implement approaches lessening such take.

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2.3.14 Applicant-Committed Environmental Protection Measures (ACEPMs)

Under Alternative D, Newfield has committed to the following measures to reduce the potential environmental impacts of the proposed oil and natural gas development and waterflooding operations within the MBPA. The following ACEPMs would apply to all Federal lands within the MBPA.

2.3.14.1 Air Quality

2.3.14.1.1 General

- Newfield would use water or other BLM-approved dust suppressants as needed during drilling, completion, and high traffic production operations for dust abatement.

- Newfield employees would comply with posted speed limits on unpaved county roads used for access and would use safe vehicle speeds on other unpaved access roads. Newfield would instruct contractors to comply with posted speed limits.

- The use of carpooling would be encouraged to minimize vehicle traffic and related emissions and Newfield would implement a vehicle policy to minimize idling while also recognizing safety concerns.

- Newfield would conduct a pilot test to evaluate the feasibility for converting fleet vehicles to cleaner-burning compressed natural gas (CNG) or liquefied natural gas (LNG) fuels. The results of this pilot test would be submitted to the AO.

2.3.14.1.2 Drilling / Completion Operations

- Newfield would use Tier II diesel drill rig engines or equivalent, with the phase-in of Tier IV engines or equivalent emission reduction technology by 2018.

- Newfield would employ reduced-emission completion practices, including: storing or re-injecting recovered liquids and routing recovered gas into a well or using the recovered gas as fuel for another useful purpose when feasible; routing all saleable quality gas to a flow line as soon as practicable; and safely maximizing resource recovery and minimizing potential VOC emissions from hydraulically fractured, high-pressure gas well flowback operations (not including low-pressure oil wells). If flowback emissions cannot be routed to a flow line, they will be captured and routed to a completion combustion device, unless such device will result in a fire or explosion hazard.

2.3.14.1.3 Production Operations

- Newfield would utilize for new construction low- or intermittent-bleed pneumatic devices to minimize VOC emissions. High-bleed devices may be allowed for critical safety and/or process purposes.

- High-bleed pneumatic devices at existing Newfield facilities would be replaced/retrofitted with low- or intermittent-bleed devices when repair or replacement is warranted, and no later than 6 months after the ROD is signed. High-bleed devices may be allowed to remain in service for critical safety and/or process purposes.

- Newfield would employ glycol dehydrator still vent emission controls with a control efficiency of 95 percent or greater.

- Newfield would conduct a study to evaluate the feasibility for the implementation of "low emission" glycol dehydrators. The results of this study would be submitted to the AO.

- Newfield would install emission controls with an efficiency of 95 percent on the following:
  - Tanks that have been modified or re-constructed after August 23, 2011, with the potential to emit greater than 6 tons per year (tpy) VOC
  - All other tanks with the potential to emit greater than 20 tpy per tank within 24 months of signing the ROD

- Newfield would implement a telemetry monitoring system where feasible to provide for the effective management of production exceptions, while reducing the number of vehicle trips and miles traveled.

2.3.14.1.4 Central Facilities

- Newfield would install electric motor driven compression where feasible. Where electrification is not feasible, Newfield would utilize lean-burn natural gas fired compressor engines or equivalent rich-burn engines with catalysts. Lean-burn engines would be fitted with oxidation catalysts to minimize carbon monoxide and VOC emissions.

- Newfield would maximize the use of central compression, thereby reducing the need for smaller and less efficient (higher emission) well site compressor units.

- Newfield would periodically replace rod packing systems on reciprocating compressors and use only dry seals on centrifugal compressors to minimize the loss of VOC.

- Newfield would employ glycol dehydrator still vent emission controls with a control efficiency of 95 percent or greater.

- Newfield would install emission controls with an efficiency of 95 percent or greater on stock tanks that have the potential to emit VOC greater than 6 tpy.

2.3.14.1.5 GOSP Implementation

- Where feasible, Newfield would implement Green River oil gathering systems and construct GOSPs. With GOSP implementation, the majority of the stock tanks, produced water tanks, and related tank heaters at affected existing well sites would be removed from service. New wells served by a GOSP would be constructed without tank batteries, thereby eliminating tank battery and related tanker truck emissions.

- The GOSP facilities would be specifically designed to minimize the emission of VOC. Storage tank emissions would be captured and reused within the facility process or sold as product. Vapors from truck loading operations would be controlled by 95 percent.

2.3.14.1.6 Monitoring Programs

- Newfield would annually evaluate the deep gas gathering system to identify opportunities for pressure optimization resulting in reduced flash emissions from condensate storage tanks.

- Newfield would implement visual inspections of thief hatch seals and pressure relief valves on condensate tanks to ensure proper operation and minimize losses of VOCs. Inspections will be conducted at least annually during a routine maintenance visit. If for some reason monitoring does not occur within 12 months, the visual inspection will be conducted at the next scheduled maintenance visit.

2.3.14.1.7 Adaptive Management

- Newfield would implement the adaptive management program described in **Section 2.3.11**, would evaluate project specific emissions on an annual basis, and would identify opportunities to further reduce emissions.

2.3.14.1.8 Cooperative Efforts and Outreach

- Newfield would encourage and lend technical support to scientific research efforts focused on improving the understanding of ozone formation chemistry within the Uinta Basin, emission inventory enhancements, source apportionment studies, ozone precursor transport studies, precursor sensitivity studies, and evaluations of cost effective control strategies.

- Newfield would incorporate ozone awareness and specific actions for reducing ozone precursor emissions into the current employee training program.

2.3.14.2 Paleontological Resources

- Paleontological surveys would be conducted by an SMA-approved paleontologist prior to any surface disturbance on State and Federal surface.

- If fossils are encountered during the survey, the paleontologist would assess and document the discovery, and either collect the fossils or recommend the area be avoided so as not to destroy the resource.

- The AO of the SMA would determine the need for further monitoring of the area or mitigation of the site during ground-disturbing activities.

- If paleontological resources are encountered during excavation, construction would be suspended, and the AO of the SMA would be notified. Construction would not resume until the paleontological resources are assessed by the AO of the SMA, and appropriate mitigation measures are developed and implemented.

2.3.14.3 Soil Resources

- During project construction, surface disturbance and placement of gas and water lines would be limited to the approved location and access routes.

- No oil, lubricants, or toxic substances would be drained onto the ground surface.

- All areas used for soil storage would be stripped of topsoil before soil placement.

- Where directed by the appropriate SMA, Newfield would construct erosion control devices (e.g., riprap, bales, and heavy vegetation) at culvert outlets. All construction activities would be performed to retain natural water flows to the greatest extent possible.

- In areas with unstable soils where seeding alone may not adequately control erosion, grading would be used to minimize slopes and water bars would be installed on disturbed slopes.

- Erosion control efforts would be monitored by Newfield, and modifications would be made to control erosion if necessary.

- Erosion protection and silt retention would be provided by the construction of silt catchment dams where needed and as feasible.

2.3.14.4 Water Resources, Including Floodplains

- Produced liquid and natural gas gathering pipelines that are buried across water courses would be buried in accordance with guidelines established in the *Gold Book* and *Hydraulic Considerations for Pipelines Crossing Stream Channels*, Technical Note 423, April 2007. Specific burial depths for natural gas and produced liquids pipelines that cross perennial, intermittent, and ephemeral stream channels within the MBPA would be determined during the onsite process.

- In accordance with 40 CFR 112.3, Newfield would prepare and maintain SPCC plans for active facilities. Newfield would inspect each facility subject to SPCC requirements on an annual basis to ensure appropriate spill prevention measures are maintained. A management review of the SPCC plans would be conducted every 5 years.

- Newfield employees would be trained annually in spill prevention and reporting requirements. Contractors would be required to promptly report all accidental releases to a Newfield Supervisor.

- Newfield would use closed-loop drilling techniques for all proposed wells located in sensitive areas, such as the 100-year floodplain of Pariette Draw, and in all U.S. Geological Survey (USGS) named drainages within 3 miles of the Green River. Additional locations where closed-loop drilling may be merited would be determined during the onsite process.

- Newly constructed gas and water lines would be pressure tested to evaluate structural soundness and reduce the potential for leaks.

- Springs will be delineated and marked on maps and on the ground before development.

2.3.14.5 Vegetation, Including Noxious and Invasive Species and Wetland/Riparian Areas and Threatened, Endangered, or BLM Special-status Plant Species

- As required by the Endangered Species Act (ESA) of 1973, as amended, no activities would be permitted that would jeopardize the continued existence of threatened or endangered plant species.

- As required by the Noxious Weed Act of 1974, as amended, and by Executive Order 13112-1999, noxious weeds would be controlled in the MBPA by Newfield on all disturbances associated with its existing well pads, road, and pipeline routes, as well as infestations that would occur as a result of the project.

- Removal and disturbance of vegetation would be kept to a minimum through construction site management (e.g., using previously disturbed areas and existing easements where feasible, placing pipelines adjacent to roads, limiting well pad expansion, etc.).

- In an effort to ensure that project activities do not increase the existence of invasive or noxious weeds in the MBPA, Newfield would prepare a Weed Control Plan. Specific components of the plan would include:

    - Conducting individual noxious weed inventories on a well-by-well basis prior to construction activities. The inventories would include examination of all proposed surface disturbance (i.e., roads, pipelines, and well pads) associated with each well. The results of these inventories would include Global Positioning System (GPS) locations indicating the type and size of each infestation. This data would be formulated into a report and submitted with the APD.

    - Preparation of a Pesticide Use Proposal (PUP).

    - Following the construction phase and drilling phase for each well, all disturbed surface would be monitored annually for the presence of noxious weeds. If monitoring shows the presence of noxious weeds, Newfield would be responsible for treating these areas. Noxious plant control measures (mechanical, cultural, chemical) would be conducted annually prior to seed set. Monitoring and treatment would be conducted annually until reclamation and weed eradication is deemed successful by the AO of the appropriate SMA.

    - All herbicide chemical control will be in conformance with national and local guidance, including approved chemicals, rates, and appropriate BMPs.

    - To prevent further spread of noxious weeds, all vehicles and equipment would be power washed at designated washing locations to remove seed and plant materials before entering the MBPA from outside of the Uinta Basin.

    - Springs will be delineated and marked on maps and on the ground before development.

2.3.14.6 Livestock Grazing

- Newfield would repair or replace any fences, cattle guards, gates, drift fences, and natural barriers that are damaged as a result of the proposed project. Cattle guards or gates would be installed for livestock control on roads when fences are crossed, and these structures would be maintained by Newfield for the life of the road.

2.2.14.7 Fish and Wildlife Including Special Status Fish and Wildlife Species

- As required by *Onshore Oil and Gas Order No. 1*, Newfield would remove any visible accumulation of oil from the reserve pit immediately upon release of drilling rig to prevent exposure of migratory birds and other wildlife to petroleum products.

- To minimize wildlife mortality due to vehicle collisions, Newfield would advise project personnel regarding appropriate speed limits in the MBPA.

- Employees and contractors would be educated about anti-poaching laws.

- If wildlife law violations are discovered, the offending employee would be subject to disciplinary action by Newfield. All wildlife law violations would be reported to the UDWR.

- Annual raptor surveys within the MBPA would be conducted by a BLM-qualified biologist.

- To reduce potential stress from facility construction to antelope, Newfield would install two antelope guzzlers per year for five years within the MBPA. These new facilities would not be subject to setbacks.

- For any surface-disturbing activities proposed between January 1 and September 31, a BLM-approved biologist would survey proposed development sites for the presence of raptor nests. The survey area would be determined on a site-specific basis by the AO of the appropriate SMA. On BLM lands, if occupied/active raptor nests are found, construction would not occur during the nesting season for that species within the species-specific buffer described in "Best Management Practices for Raptors and Their Associated Habitats in Utah." As specified in the Raptor BMPs, modifications of these spatial and seasonal buffers for BLM-authorized actions would be permitted, so long as protection of nesting raptors was ensured (see Appendix A of the Vernal ROD and Approved RMP) (BLM 2008b). Fee and SITLA lands would be excluded from this measure.

2.3.14.8 Cultural Resources

- A Class III inventory would be conducted in all areas within Federal lands proposed for surface disturbance. These surveys would be conducted on a site-specific basis prior to the initiation of construction activities.

- Whenever feasible, prehistoric and historic sites documented during the Class III inventory as eligible for listing on the National Register of Historic Places (NRHP), as well as areas identified as having a high probability of subsurface materials, would be avoided by development. Specifically, well pad locations and access/gas and water line routes would be altered or rerouted as necessary to avoid impacting NRHP-eligible sites.

- If avoidance is not feasible or does not provide the required protection, adverse effects would be mitigated (e.g., data recovery through excavation).

- Newfield would inform their employees, contractors, and subcontractors about relevant Federal regulations intended to protect archaeological and cultural resources. All personnel would be informed that collecting artifacts is a violation of Federal law and that employees engaged in this activity would be subject to disciplinary action.

- If cultural resources are uncovered during surface-disturbing activities, Newfield would suspend operations at the site and immediately contact the appropriate AO, who would arrange for a determination of eligibility in consultation with the Utah State Historic Preservation Office (SHPO) and if necessary, would recommend a recovery or avoidance plan.

2.3.14.9 Visual Resources

- To reduce visual impacts to recreationists using the Green River, low-profile tanks would be used at all well pads located within 0.5 mile or within line of sight (whichever is less) of the Green River.

2.3.14.10 Health and Safety/Hazardous Materials

- Newfield would institute a Hazard Communication Program (HCP) for its employees and require the subcontractor to operate in accordance with Occupational Safety and Health Administration (OSHA) (29 CFR 1910.1200).

- As required by OSHA, Newfield would place warning signs near hazardous areas and along access roads.

- In accordance with 29 CFR 1910.1200, a Material Safety Data Sheet (MSDS) for every chemical or hazardous material brought on-site would be kept on file in Newfield's field office.

- Newfield would transport and/or dispose of any hazardous wastes, as defined by the Resource Conservation and Recovery Act of 1976 (RCRA), as amended, in accordance with all applicable Federal, State, and local regulations.

- All storage tanks that contain produced water, or other fluids which may constitute a hazard to public health or safety, would be surrounded by a secondary means of containment for the entire contents of the tank plus freeboard for precipitation, or 110 percent of the capacity of the largest tank. Production facilities that have the potential to leak produced water, or other fluids which may constitute a hazard to public health or safety, would be placed within an appropriate containment and/or diversionary structure to prevent spilled or leaking fluid from reaching groundwater or surface waters.

- Notice of any reportable spill or leakage, as defined in BLM NTL 3A, would be reported by Newfield to the AO of the appropriate SMA as required by law. Oral notice would be given as soon as possible, but within no more than 24 hours, and those oral notices would be confirmed in writing within 72 hours of any such occurrence.

- Newfield would provide portable sanitation facilities at drill sites, would place trash cages at each construction site to collect and store garbage and refuse, and would ensure that all garbage and refuse is transported to a State-approved sanitary landfill for disposal.

2.3.15 Regional Mitigation

In accordance with BLM Washington Office Instruction Memorandum 2014-142 and the Draft Regional Mitigation Manual MS-1794, the BLM may require mitigation measures and conservation actions in order to achieve this EIS's purpose and need, or to meet land use plan goals and objectives, and provide for sustained yield of natural resources on Public Lands while continuing to honor the agency's multiple-use missions. The sequence of the implementation of the ACEPM and additional mitigation action will be the mitigation hierarchy, as identified by the White House Council on Environmental Quality (CEQ) (40 CFR 1508.20), Secretarial Order 3330, and the BLM Draft - Regional Mitigation Manual Section (MS)-1794. The mitigation hierarchy includes:

- Avoiding
  - Identification of avoidance areas and/or measures (e.g. timing limitations or no surface occupancy areas) already included in laws, regulations, and/or governmental decision documents (e.g. RMPs) that govern permit authorizations.
  - Identification of additional avoidance measures for the BLM to consider (e.g. additional avoidance best management practices).
  - For a few examples in this project, refer to the ACEPM **Section 2.3.14.8** Cultural Resources 2nd bullet (avoidance of sites), **Section 2.1.1.1** 100 Year Floodplains and Riparian Areas 1st bullet (avoidance of riparian areas), and **Section 2.1.2.1** Level 1 Core Conservation Areas 2nd bullet (avoidance of new disturbance).
- Minimizing
  - Identification of minimization measures (e.g. surface use controls, conservation measures, best management practices) already included in BLM decision documents (e.g. RMPs; USFWS Biological Opinions);
  - Identification of additional minimization measures for the BLM to consider (e.g. applicant-committed design features) or other site-specific BLM identified best management practices.
  - For a few examples in this project, refer to the ACEPM **Section 2.3.14.9** Visual Resources (low profile tanks near the river), **Section 2.1.1.1** 100-Year Floodplains and Riparian Areas 4th bullet (minimize new roads and pipelines in floodplains), and **Section 2.1.1.2** Special Status Species (300-feet avoidance).
- Rectifying

- Identification of measures for the BLM to consider including repairing, rehabilitating, or restoring affected landscapes.
- For a few examples in this project, refer to the ACEPM **Section 2.3.14.6** Livestock Grazing (repairing damaged range facilities), ACEPM **Sections 2.3.5** Interim Reclamation and **2.3.7** Final Reclamation and Abandonment, **Section 2.1.1.2** Special Status (weed control in cactus habitat), and **Section 2.1.3** New Development Based on Existing Well Density 5th paragraph (reclamation of existing well pads back to one acre).

- Reducing or Eliminating
  - Identification of measures for the BLM to consider to reduce or eliminate the impact over time (e.g. interim reclamation best management practices; adaptive management mitigation) by preservation and maintenance operations during the life of the action.
  - For a few examples in this project, refer to **Section 2.3.11** Adaptive Management Strategy for Potential Adverse Ozone Formation, the ACEPM **Section 2.3.14.1.5** GOSP Implementation (reducing or eliminating truck traffic by central facility installation), and **Section 2.1.1.2** Special Status Species (dust abatement in cactus habitat).
- Compensating
  - Identification of measures for the BLM to consider to compensate for the impact by replacing or providing substitute resources or environments (e.g. contribution to monitoring fund; implementing best available technology to reduce emissions from existing wells to offset new wells).
  - For a few examples in this project, refer to ACEPM **Section 2.3.14.1.8** Cooperative Efforts and Outreach (contributing data and technical support to ozone efforts), ACEPM **Section 2.3.14.7** Fish and Wildlife Including Special Status Fish and Wildlife (building antelope guzzlers), and **Sections 2.1.1.2** Special Status Species and **2.1.2.2** Level 2 Core Conservation Area (mitigation fund contribution).

The priority is to mitigate impacts at the site of the activity in conformance with the purpose and need and land use plan goals and objectives, through impact avoidance, minimization, rectification, and reduction over time of the impact, including those measures described in laws, regulations, policies, and the land use plans. Compensatory mitigation will be implemented as necessary when the other types of mitigation measures are not sufficient to meet the purpose and need or land use plan objectives, or to ameliorate anticipated direct, indirect and cumulative impacts where substantial or significant residual impacts remain.

When applying mitigation at any level of the mitigation hierarchy, there will be requirements for monitoring the effectiveness of the mitigation as well as the durability of the mitigation (to be durable, the mitigation should meet or exceed the length of time that projected impacts would affect resources). This monitoring is necessary, especially in relation to durability for compensatory mitigation, in order to identify when it may be appropriate to consider applying adaptive management concepts to ensure continued effectiveness for the life of the project. For an example in this project, refer to **Section 2.3.11** Adaptive Management Strategy for Potential Ozone Formation.

Two important concepts related to durability are: 1) Ecological Durability - the length of time the benefits from mitigation measures persist on and influence the landscape and; 2) Protective Durability – the ecological values benefited in compensatory mitigation areas are protected from or unaffected by future conflicting land-uses or disturbances.

The ecological durability of compensatory mitigation is greatest if the areas where it is applied are large enough or strategically located so that they will, either in themselves or in conjunction with other adjacent landscape conditions or climate change predictions, provide the targeted conservation benefits. Ecological durability may be compromised when the benefits of compensatory mitigation do not persist for the full duration of the impact that is intended to be offset (e.g. from initial surface disturbance to final reclamation, rehabilitation or restoration). Damage to functioning compensatory mitigation measures may be caused by natural disturbances (such as wildfire) or anthropogenic disturbances (such as other authorized development), which shorten the intended duration of applicable mitigation.

The BLM will require that mitigation measures have a degree of protective durability. On public land, protective durability is best achieved by legal conservation designations, land use plan designations, and land use allocations, each of which offers a greater or lesser degree of protective durability. Financial protections (e.g., bonding for construction, endowment for mitigation management) are also important tools to achieve protective durability at the project implementation level. The BLM will expressly condition its approval of a project on public lands on the applicant's commitment to perform or cover the costs of mitigation, whether onsite or outside the area of impact.

2.3.16 BLM Air Quality Control Measures

Per the discussion in **Section 2.3.14.1**, the following air quality control measures would be applied under Alternative D:

- Newfield would conduct an annual emissions inventory and compare the inventory to the emissions estimates contained in this EIS. The inventory would be conducted annually for the life of the project (LOP) until the EPA/UDEQ/BLM develop an approved basin-wide control plan covering oil and gas development in the Uinta Basin.

Enhanced Inspection and Maintenance Program

- Use an IR Camera
    - Conduct representative surveys of facilities and equipment for the potential for fugitive VOC emissions.
- Conduct IR Camera or Audio, Visual, Olfactory (AVO) Surveys
    - Conduct IR camera or AVO surveys of facilities and equipment with highest potential for VOC emissions on a regularly scheduled basis and repair as practical. This practice is most effective if performed prior to the winter ozone season. Significant leaks detected with this method should be repaired within two weeks.
- Record Keeping and Reporting for IR Camera
    - Maintain records of inspections and repairs as necessary to provide an estimate of VOC reductions. Support post season efforts to compile emission reduction data. Data on the number of facilities inspected using IR or AVO methods, the number leaks repaired and an estimate of leak volume should be maintained. Data should be compiled on a monthly basis for correlation with ozone events.
- Inspect and Perform Regular Maintenance
    - Inspect and perform regular maintenance of equipment such as vehicles, pneumatic devices, dehydrators, internal combustion engines and emission control equipment.

Defer, if practical, maintenance that causes a temporary increase in emissions such as compressor blow down, to periods outside of ozone events.

- Limit Vehicle Idle Time
    - Limit vehicle idle time to the extent practical

Ozone Training for Operations Personnel – Operations personnel receive training prior to ozone season. Training programs should cover the following:

- Ozone – what it is and how it impacts air quality
- Ozone formation ingredients – NOx, VOCs, and weather conditions
- Ozone attainment status in the Uinta Basin
- Review of applicable regulations
- What can be done to prevent and/or reduce emissions of ozone precursor gases – limit driving, maintain equipment, delay optional activities until after inversion, etc. Emphasize importance of proper maintenance of tank hatches, vapor combustors, and other equipment that reduces emissions.

Work Practices

- Dehydrators
    - Optimize dehydrator recirculation rates for the prevailing conditions
- Venting Blow Downs
    - Defer and/or minimize blow down of wells, pipelines, and pressure vessels during ozone events
- Pneumatic Pumps
    - Adjust and optimize pneumatic heat trace pump rates for the prevailing conditions
- General Episodic Practices
    - To the extent practical, defer and/or otherwise schedule activities that may contribute to ozone formation to periods outside of ozone events

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3.0 AFFECTED ENVIRONMENT

This chapter discusses the physical, biological, social, and economic factors as they currently exist within the MBPA and surrounding region. Management issues identified by the BLM VFO, public scoping, and interdisciplinary analysis of the MBPA have provided guidance on the material presented herein.

The area of the affected environment for individual resources was assessed based on the area of potential direct and indirect environmental impacts. For most resources, the affected environment includes the immediate boundaries of the MBPA. However, some resources (e.g., watersheds, air quality, and socioeconomics) are addressed in a larger regional context.

3.1 GENERAL SETTING

The MBPA is located within the Uinta Basin of the Colorado Plateau physiographic province. The basin is a bowl-shaped structural and sedimentary feature that trends roughly east to west, has a maximum width of about 115 miles, and covers an area of approximately 10,890 square miles. The basin is bounded on the north by the Uinta Mountains and on the east by the Douglas Creek Arch, with portions of the Wasatch Range and the Roan Cliffs forming its western and southern boundaries.

Elevation within the MBPA ranges from approximately 4,632 feet above mean sea level (amsl), in the eastern portion near the Green River, to approximately 6,867 feet amsl, in the southwestern portion near Gilsonite Draw. Numerous drainages transect the MBPA, including Wells Draw, Castle Peak Draw, Petes Wash, Sheep Wash, Big Wash, and a number of other unnamed ephemeral features. These drainages, in combination with the plateaus of Pariette Bench and Eight Mile Flat, create a pattern of uplands and lowlands oriented southwest to northeast.

The vegetation within the MBPA and surrounding region consists of typical Intermountain Basin shrubland associations. This region mixes an array of geographic substrates, topographic features, climatic regimes, soil types, and other physical factors to produce a mosaic of floristic components and associated natural habitats. These ecological communities are often mixed, transitional, or widely distributed.

The MBPA encompasses approximately 119,743 acres of land within southeastern Duchesne County and southwestern Uintah County. The MBPA spans a distance of approximately 25 miles east to west and 9 miles north to south. The Town of Vernal is approximately 33 miles northeast of the MBPA boundary, and Myton, is located approximately 5.5 miles to the north. Land ownership in the MBPA is approximately 87 percent Federal (managed by the BLM), approximately 11 percent State of Utah (managed by SITLA), and approximately 2 percent private. Mineral interests are owned by the BLM (89 percent), the State of Utah (10 percent), and private interests (less than 1 percent). Lands with separate surface and mineral ownership, also known as “split estate lands,” comprise approximately 18 percent of land within the MBPA.

3.2 SPECIAL STATUS SPECIES AND STATE SPECIES OF CONCERN

Special status plant, fish, and wildlife species include those listed as threatened or endangered under the ESA of 1973, as amended; BLM sensitive species; species proposed for listing; species of special concern; other USFWS or BLM species identified as unique or rare; other UDWR or Utah Natural Heritage Program (UNHP) species designated as unique or rare, and which have the potential to occur within the MBPA and surrounding region. The ESA provides protection to federally listed threatened and endangered species from any action that may jeopardize their existence. Species proposed for listing are not protected by the ESA; however, the USFWS works with states, Tribes, private landowners, private partners, and other federal agencies to carry out conservation actions that prevent further decline of proposed species and possibly eliminate the need for the species to be listed.

Under provisions of Section 7 (a)(2) of the ESA (16 U.S.C. Section 1536), federal agencies must ensure that any action authorized, funded, or implemented by the agency does not jeopardize the continued existence of any species listed or result in the destruction or adverse modification of critical habitat of such species. BLM Manual 6840—Special Status Species Policy requires the agency to manage and protect BLM sensitive species, which include: species listed or proposed for listing under the ESA; species requiring special management consideration to promote their conservation and reduce the likelihood and need for future listing under the ESA; species designated as BLM sensitive by the State Director; and all federal candidate species, proposed species, and delisted species in the 5 years following delisting. This policy requires BLM to manage BLM sensitive species to reduce the likelihood for such species to be listed pursuant to the ESA.

Based on examination of USFWS, BLM, UDWR, and UNHP data, a total of 25 special status plant species and 33 special status fish and wildlife species were identified as potentially occurring within the MBPA (refer to **Attachment A** and **Attachment B**). Of the 58 special status plant, fish, and wildlife species that were evaluated, 18 plant species and nine fish and wildlife species were eliminated from further consideration in this EIS, because either the geographic or elevational range of the species is located outside of the MBPA and/or the MBPA does not provide suitable habitat for the species. The remaining 31 species that have the potential to occur within the MBPA are retained for further evaluation and include eight federally listed species and 21 BLM sensitive species and/or UNHP species of concern (refer to **Attachment A** and **Attachment B**). These species are described further below.

3.2.1 Federally Threatened, Endangered, or Proposed Species

Table 3.2.1-1 lists federally listed threatened and endangered species that are identified as potentially occurring within the MBPA. A total of eight species or subspecies of plants and animals are addressed in the EIS, four of which are federally listed as endangered, three of which are federally listed as threatened, and one of which is listed as a candidate species. Critical habitat has been designated for four of these species, as indicated in **Table 3.2.1-1** below.

The evaluation of federally listed threatened and endangered species in this EIS fulfills the compliance requirements of pertinent environmental laws, regulations, and policies in accordance with the requirements of Section 7(b) of the ESA of 1973, as amended, and implementing regulations [16 United States Code (U.S.C.) 1536 (c), 50 CFR 402.12 (f) and 402.14 (c)], and ESA guidance contained in the Endangered Species Consultation Handbook (USFWS and National Marine Fisheries Service 1998).

It is the policy of USFWS to consider candidate species when making natural resource decisions. Consequently, candidate species will be included for consideration in this EIS. Biological information on the above-mentioned species is discussed below.

TABLE 3.2.1-1
FEDERALLY LISTED SPECIES CONSIDERED FOR EVALUATION IN THE EIS/BA

Species	Status	Species Listing		Critical Habitat		Abundance	Primary Habitat Use
		Date Listed	Federal Register No.	Date Designated	Federal Register No.		
Birds							
Yellow-billed cuckoo (*Coccyzus americanus*)	T	October 3, 2014	79 FR 59991	Proposed August 15, 2014	79 FR 48547	Uncommon Summer	Riparian Habitats
Fish							
Colorado pikeminnow (*Ptychocheilus lucius*)	E	March 11, 1967	32 FR 4001	March 21, 1994	59 FR 13374	Rare; Green River is an important nursing area	Riverine & Wetlands/ Bottomlands
Bonytail chub (*Gila elegans*)	E	April 23, 1980	45 FR 27713	March 21, 1994	59 FR 13374	Rare; No wild caught in several years	Riverine
Razorback sucker (*Xyrauchen texanus*)	E	October 23, 1991	56 FR 54957	March 21, 1994	59 FR 13374	Rare; Severely reduced in numbers	Riverine & Wetlands/ Bottomlands
Humpback chub (*Gila cypha*)	E	March 11, 1967	32 FR 4001	March 21, 1994	59 FR 13374	Rare; Severely reduced in numbers	Riverine
Plants							
Uinta Basin hookless cactus (*Sclerocactus wetlandicus*)	T	October 11, 1979	44 FR 58869	N/A	N/A	Uncommon to Common	Dry Gravel Terraces
Pariette Cactus (*S. brevispinus*)	T	Original Listing: October 11, 1979 Revised Listing: September 15, 2009	Original Listing: 44 FR 58868 Revised Listing: 74 FR 47112	N/A	N/A	Occurring only in the Pariette Draw	Clay Badlands
Ute ladies'-tresses (*Spiranthes diluvialis*)	T	January 17, 1992	57 FR 2048	N/A	N/A	Rare	Floodplains and Perennial Stream Terraces

E = Endangered, T = Threatened, C = Candidate

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3.2.1.1 Fish and Wildlife

3.2.1.1.1 Western Yellow-billed Cuckoo

The western yellow-billed cuckoo (WYBC) (*Coccyzus americanus*) is listed as a threatened species under the ESA. This species is a neotropical migratory species that breeds in the U.S. and Canada and winters in South America (USFWS 2001). Currently, the range of the cuckoo is limited to disjunct fragments of riparian habitats from northern Utah, western Colorado, southwestern Wyoming, and southeastern Idaho, southward into northwestern Mexico, and westward into southern Nevada and California. Cuckoos are long-range migrants that winter in northern South America in tropical deciduous and evergreen forests (Ehrlich et al. 1988).

Historically, cuckoos were probably common to uncommon summer residents in Utah and across the Great Basin (Ryser 1985, Hayward et al. 1976). The current distribution of WYBCs in Utah is poorly understood, though they appear to be an extremely rare breeder in lowland riparian habitats statewide (Walters 1983, Behle 1981, Benton 1987).

WYBCs are one of the latest migrants to arrive and breed in Utah. They arrive in extremely late May or early June and breed in late June through July. Cuckoos typically start their southerly migration by late August or early September. WYBCs feed almost entirely on large insects that they glean from tree and shrub foliage. They feed primarily on caterpillars, including tent caterpillars. They also feed frequently on grasshoppers, cicadas, beetles, and katydids, occasionally on lizards, frogs, and eggs of other birds, and rarely on berries and fruits (Ehrlich et al. 1988, Kaufman 1996).

The cuckoo is a riparian obligate bird that feeds in cottonwood groves and nests in willow thickets. Nesting habitat is classified as dense lowland riparian that is characterized by a dense sub-canopy or shrub layer (regenerating canopy trees, willows, or other riparian shrubs) within 300 feet of water. Overstory in these habitats may be either large, gallery-forming trees (30 to 90 feet in height) or developing trees (10 to 30 feet in height), usually cottonwoods. No USFWS proposed critical habitat for this species occurs within the GMBU Project Area. Nesting habitats are found at low to mid-elevations (2,500 to 6,000 feet amsl) in Utah. Cuckoos may require large tracts (100 to 200 acres) of contiguous riparian nesting habitat; however, cuckoos are not strongly territorial and home ranges may overlap during the breeding season. Nests are usually 4 to 8 feet above the ground on the horizontal limb of a deciduous tree or shrub, but nest heights may range from 3 to 20 feet and higher. In Utah, this species nests in riparian areas and has been documented in cottonwood habitat along the Green River.

3.2.1.1.2 Colorado Pikeminnow

The Colorado pikeminnow (*Ptychocheilus lucius*), formerly the Colorado squawfish, is a federally endangered fish species under the ESA. This species is endemic to the Colorado River Basin habitats that are characterized by variable flow, turbulent water, and high silt loads. Within the Colorado River Basin, the Colorado pikeminnow is known to inhabit the Colorado, Green, Duchesne, Price, San Rafael, Gunnison, San Juan, White, and Delores Rivers and numerous associated streams. Today, the species is most abundant in the Green River below the confluence with the Yampa River; the White River from Taylor Draw Dam near Rangely, Colorado, downstream to the confluence with the Green River; and the main stem of the Colorado River from Palisade, Colorado, to Lake Powell. The Gray Canyon and the Yampa River of the lower Green River hold the two critical spawning sites of this species (USFWS 2002b).

The USFWS has designated a total of 726 river miles in Utah as critical habitat for the Colorado pikeminnow. This critical habitat occurs in portions of the Green, Colorado, White, and San Juan Rivers and their respective 100-year floodplains, including portions of the Green River that flow east of the MBPA (USFWS 2007a).

3.2.1.1.3 Bonytail Chub

The bonytail chub (*Gila elegans*) is a federally endangered fish under the ESA. The bonytail chub has historically been a common species along the Colorado River system, but the population has dwindled in recent years (USFWS 1994). This may be due to the introduction of 40 non-native species of riverine fish such as the green sunfish, smallmouth bass, and channel catfish. The bonytail chub is adapted to major river habitats, where it has been observed in slow moving pools and eddies. Flooded bottomland habitat is important for growth and conditioning for young bonytail chub and acts as a nursery or transitioning habitat. There are currently no self-sustaining wild populations of bonytail chub. While very few individuals have been caught in the Upper Colorado River Basin, there have been several individuals caught in the Green River at Hideout Canyon and Gray Canyon, and at the confluence of the Colorado and Green Rivers. The release of hatchery-born bonytail chub into the Upper Colorado River Basin has resulted in low survival, reproduction, and recruitment to the population (USFWS 2002c).

In Utah, the USFWS has designated a total of 139 river miles and their associated 100-year floodplains as critical habitat for the bonytail chub in portions of the Green River and Colorado River. The closest designated critical habitat is located in the Green River, approximately 20 miles downstream from the MBPA (USFWS 2007a).

3.2.1.1.4 Razorback Sucker

The razorback sucker (*Xyrauchen texanus*) is a federally endangered fish species under the ESA. The razorback sucker currently populates the Green River, upper Colorado River, and San Juan River subbasins in the Upper Colorado River Basin. The general population consists of mostly aged adults with minimal recruitment; however, in the middle Green River, where there are juveniles and young adults, there is a low degree of recruitment. The largest population of razorback sucker exists in low-gradient, flat-water reaches of the middle Green River between the confluences with the Duchesne River and the Yampa River (USFWS 2002d). Razorback suckers tend to occupy habitat types such as impounded and riverine areas, eddies, gravel pits, flooded mouths and tributary streams, backwaters, flooded bottoms, and sandy riffles. Adults move into flooded areas in spring to begin spawning migrations as they become reproductively active. Spawning typically occurs over rocky runs and gravel bars (USFWS 2002d).

The USFWS has designated a total of 688 river miles in Utah as critical habitat for the razorback sucker. This critical habitat occurs in portions of the Green, Colorado, Duchesne, White, and San Juan Rivers and their respective 100-year floodplains, including portions of the Green River that flow east of the MBPA (USFWS 2007a).

3.2.1.1.5 Humpback Chub

The humpback chub (*Gila cypha*) is listed as federally endangered fish species under the ESA. In Utah, individuals have inhabited riverine areas from the Upper Green River near Desolation Canyon down to the lower Yampa River, the White River, and the Colorado River below the Glen Canyon Dam. Humpback chub are found in river canyons, where they occupy habitats such as river pools, riffles, eddies, rocky runs, and travertine dams. The densest concentrations of humpback chub are in the Westwater Canyon and Grand Canyon reaches of the Colorado River. Humpback chub in the Desolation and Gray Canyons of the Green River hold the third most abundant population of this species (USFWS 2002e).

In Utah, the USFWS has designated a total of 139 river miles and their associated 100-year floodplains as critical habitat for the humpback chub in portions of the Green River and Colorado River. The closest designated critical habitat is located in the Green River approximately 20 miles downstream from the MBPA (USFWS 2007a).

3.2.1.1.6 Greater Sage-Grouse

Widespread declines in greater sage-grouse populations throughout the West led to a petition to list the species as threatened under the ESA. Based on accumulated scientific data and new peer-reviewed information and analysis (USFWS 2010c), the USFWS published a finding in the *Federal Register* (50 CFR 17) on March 5, 2010, stating that the greater sage-grouse warrants the protection of the ESA, but listing the species is precluded by the need to address higher-priority species first. The greater sage-grouse was placed on the candidate list for future action, meaning that the species will not receive statutory protection under the ESA at this time, and states will continue to be responsible for managing the species. The species is currently listed as a BLM sensitive species.

In Utah, the greater sage-grouse inhabits upland sagebrush grasslands, foothills, and mountain valleys (BLM 2008b, UDWR 2009b). Depending on the season, weather, and nutritional requirements, this species occupies different habitat types during the year. Important areas for sage-grouse are the leks, brood rearing areas, and wintering areas. Leks may be located between summer and winter ranges, or, in some cases, summer and winter ranges may be the same (Call and Maser 1985). Preferred nesting habitat occurs up to a 5-mile radius from the leks (Connelly et al. 2000).

Nesting habitats consist of shallow depressions lined with grass or twigs, and are usually located under sagebrush. The principal sage-grouse winter food is sagebrush leaves. During the summer, greater sage-grouse feed on the leaves and fruiting heads of sagebrush; the flower heads of clovers, dandelions, grasses, and other plants; and various insects (Kaufman 1996, UDWR 2002). Greater sage-grouse feed almost exclusively on sagebrush in the winter (Connelly et al. 2000, Patterson 1952), and therefore, are mostly restricted to sagebrush habitats during that season. Because sage-grouse need to access sagebrush, winter habitat tends to exist on south- to west-facing slopes that are less than 10 percent slope and are generally located in windswept areas (Beck 1977, Crawford et al. 2004), where the height of sagebrush exceeds the depth of snow.

The BLM Washington Office IMs No. 2012-043 and 2012-044 (BLM 2011b, 2011c) supplement the BLM's 2004 National Strategy for sage-grouse and identify those management actions necessary to sustain sage-grouse populations, while achieving the DOI's energy-related priorities. The UDWR has not yet identified priority habitat using a consistent methodology. A priority habitat designation is the highest conservation value that can be given relative to maintaining suitable sage-grouse populations range-wide. The Governor's task force finalized the Conservation Plan for Greater Sage Grouse in Utah in February 2013. The Plan identifies Preliminary Priority Habitat (PPH) and the Preliminary General Habitat for sage-grouse in accordance with IM 2012-044. Neither of these habitats are mapped within the MBPA. No habitats designated as occupied, brood rearing, or winter habitats for sage-grouse occur within the MBPA. However, an historic sage-grouse lek is located in the MBPA. The lek is known as the Myton Bench – Wells Draw lek and was last reported active in 1999, with six males in attendance (BLM 2009b).

3.2.1.2 Plants

3.2.1.2.1 Pariette Cactus and Uinta Basin Hookless Cactus

Both the Pariette cactus and Uinta Basin hookless cactus are federally listed as threatened (USFWS 1979, 2009a). Pariette cactus (Heil and Porter 1994) and Uinta Basin hookless cactus (Hochstätter 1989) were formerly included in the federally threatened *Sclerocactus glaucus* (Schumann) Benson species "complex," but are now recognized by the USFWS as distinct species, each retaining its status as federally threatened (USFWS 2007b, 2009b). Separation of the *S. glaucus* species complex into three distinct species is supported by recent genetic studies (Porter et al. 2000, 2006), common garden experiments (Hochstätter 1993a; Welsh et al. 2003), and morphological characteristics (Hochstätter 1993b, Heil and Porter 2004). The former *S. glaucus* species complex populations now recognized as *Sclerocactus glaucus*, or Colorado hookless cactus, occur entirely within the upper Colorado and Gunnison River valleys of western Colorado (USFWS 1990, 2007b) and will not be addressed here. A recovery plan for Uinta Basin hookless cactus (the *S. glaucus* species complex) was published in 1990 (USFWS 1990), prior to the taxonomic revision of the species complex into three distinct species (USFWS 2009b). Recovery outlines were published in April 2010 for Uinta Basin hookless cactus (USFWS 2010a) and Pariette cactus (USFWS 2010b). The original recovery criteria for the *S. glaucus* species complex are no longer sufficient to address the recovery of the now separated species. As such, newly revised recovery plans for the Uinta Basin hookless cactus and Pariette cactus are in development.

The Pariette cactus and Uinta Basin hookless cactus are discussed in the following sections.

Pariette Cactus

Pariette cactus (*S. brevispinus)* is a perennial that occurs as a solitary, unbranched, egg-shaped to short cylindric succulent stem, usually 0.75–2.75 inches in diameter by 1 to 3 inches tall, that produces pink to purplish flowers from late April to May (Heil and Porter 2004). The Pariette cactus is distinguished from Uinta Basin hookless cactus by its spherical shape, short-hooked or absent central spines, smaller stature, flower size, and retention of juvenile vegetative characteristics in adult flowering plants (Heil and Porter 2004).

The Pariette cactus occurs on fine soils in clay badlands derived from the Uinta Formation within sparsely vegetated salt desert shrubland that is dominated by shadscale, rabbitbrush, and horsebrush from 4,600 to 4,900 feet amsl (USFWS 1990, Heil and Porter 2004). One of the reasons for the susceptibility of Pariette cactus to irreversible population reduction is its specific requirement for habitat with a high percentage of channels on the surface, which form a "desert pavement." Surface disturbance and construction cause the damage or removal of this unique soil substrate, which makes reclamation challenging.

The conservative minimum estimate for the total population of *S. brevispinus* is somewhere in the range of 22,000-29,000 plants within a 204-square-mile (75,400-acre) area from the Pariette Draw along the Duchesne-Uintah County boundary (USFWS 2012b). Suitable habitat for *S. brevispinus* is not continuous across this area; it is irregularly distributed across the landscape within the area identified as potential habitat. The total area of potential habitat for Pariette cactus is estimated to be about 31,000 acres on BLM lands, and approximately 17,960 acres on Ute Tribal lands (USFWS 2012b). Of the potential *S. brevispinus* habitat on BLM land, 100 percent has been leased for oil and gas development by Newfield Exploration Company and Newfield Energy, which includes the MBPA (USFWS 2012b).

Uinta Basin Hookless Cactus

The Uinta Basin hookless cactus (*S. wetlandicus)* is a perennial that occurs as a solitary, unbranched, round-to-elongate/cylindric succulent stem, usually 1.25–3.5 inches in diameter by 2 to 5 inches tall, that produces pink to violet flowers from late April to May (Heil and Porter 2004). Observed pollinators include bees, beetles, ants, and flies. Seed dispersal vectors include gravity, ants, birds, rodents, precipitation, and surface water flows. It is theorized that seed dispersal is a limiting factor in the distribution of the species (USFWS 1990). Very little is known about the factors affecting the distribution and long-term population dynamics of the Uinta Basin hookless cactus.

Information on the habitat requirements and distribution of this species has been rapidly changing as more studies and surveys are conducted in the Uinta Basin. Currently, the species is known to occur on Quaternary and Tertiary alluvium soils overlain with cobbles and pebbles of the Duchesne River, Green River, and Uinta Formations between 4,500 to 6,600 feet amsl (BLM 2008b, UNPS 2007). It is also found on gravelly hills and terraces, river benches, valley slopes, and rolling hills along the Green, White, and Duchesne Rivers. Preferred habitat is generally associated with Pleistocene outwash terraces with coarse-textured, alkaline soils overlain by a surficial pavement of large, smooth, rounded cobble. It can be found in a range of vegetative communities, including clay badlands, salt desert shrub, and pinyon-juniper woodlands. Associated species include black sagebrush, shadscale saltbush, James' galleta, and Indian ricegrass.

In 2010, the USFWS developed a potential habitat polygon for *S. wetlandicus* and *S. brevispinus* to better assess possible impacts to the species within its range. Although *S. wetlandicus* and *S. brevispinus* populations can be found outside of these areas, they tend to occur at greater numbers and at higher densities within these polygons. The potential habitat polygon is updated annually and was last updated in March 2013 (USFWS 2013).

The total area of potential habitat for *S. wetlandicus* is currently 442,000 acres and includes federal, tribal, state, and private surface lands. Recent geographic data for *S. wetlandicus* includes more than 18,400 points, representing approximately 40,528 individual cacti. Approximately 57,442 acres of USFWS-designated potential habitat for the *S. wetlandicus* has been identified within the MBPA. **Figure 3.10.1.2-1 (Attachment 1)** shows potential cactus habitat areas within the MBPA boundary.

Management Areas for Both Sclerocactus Species

Within known and potential habitat for the Uinta Basin hookless cactus and Pariette cactus, the USFWS has proposed core conservation areas and management recommendations for *S. wetlandicus* and *S. brevispinus* species in response to the ongoing energy development in the Uinta Basin (**FEIS Appendix I**). The purpose of the proposed core conservation areas and management recommendations is to protect the most important populations or sub-populations, and reduce threats to both *Sclerocactus* species. Two levels of core conservation areas were developed based on pollinator travel distance and habitat connectivity between populations and individuals. The core areas are centered on the densest known areas of *Sclerocactus* within a 400 meter (approximately 1,312 foot) buffer for Level 1 and 1,000 meter (approximately 3,821 foot) buffer for Level 2 areas. The Level 1 and Level 2 polygons were developed using kernel density analysis found in GIS software.

The distances used to develop core conservation areas were based on travel distances of common bee species that visit individual plants. These bees are in the small and medium size range and travel approximately 400 to 1,000 meters between plants and nests (Tepedino et al. 2010). Level 1 polygons were developed using a 400-meter buffer around plants to allow for pollinator travel. They include the densest concentrations of cactus locations and the most restrictive management recommendations as proposed by USFWS. Level 2 polygons were developed using a 1,000-meter buffer around plants while incorporating less-dense cactus areas and less restrictive management recommendations as proposed by USFWS. It is important to note that at the time this document was developed, these proposed measures are interim management recommendations that have not been finalized or formally adopted as standard mitigation practices by the BLM.

Approximately 7,484 and 12,955 acres of Level 1 and 2 Core Conservation Areas occur within the MBPA, respectively. Much of the potential habitat for *Sclerocactus*, including Level 1 and 2 Core Conservation Areas, is interspersed with and fragmented by existing oil and gas development (see **Figure 3.10.1.2-1 – Attachment 1**). According to UDOGM's database as of January 2015, there are currently 594 wells[6] located within Core Conservation Areas within the boundaries of the MBPA (162 wells in Level 1 and 432 in Level 2). The USFWS and Newfield have differing opinions on the amounts of existing surface disturbance within the Core Conservation Areas.

The USFWS applies an estimate of 5 acres per well. Using USFWS' assumptions, there are approximately 810 acres and 2,160 acres of existing disturbance within Level 1 and Level 2 Core Conservation Areas, respectively, within the MBPA boundary. It is important to note, however, that this value is highly likely to be an overestimate, as the UDOGM database does not account for multi-well pads.

Newfield estimated existing disturbance using a combination of aerial imagery, vendor data, plats, and as-built engineering diagrams. Using Newfield's assumptions, there are approximately 318.8 acres and 573.8 acres of existing disturbance within Level 1 and Level 2, Core Conservation Areas, respectively, within the MBPA boundary.

Existing surface disturbance within the entire Upper and Lower Pariette Core Conservation Area (i.e., MBPA and EDA #1 areas) is discussed in cumulative impacts in Chapter 5.0.

3.2.1.2.2 Ute Ladies'-tresses

Ute ladies'-tresses (*Spiranthes diluvialis*) is a federally listed threatened species. A member of the orchid family, this perennial herb occurs on seasonally flooded river terraces, spring-fed stream channels, lakeshores, and in human-modified and disturbed wetlands such as canals, gravel pits, and irrigated meadows (Fertig et al. 2005). Within the Uinta Basin, Ute ladies'-tresses occurs along the Green River near the confluence with the Yampa River, and along Ashley Creek, Big Brush Creek, and the upper Duchesne River and its tributaries (BLM 2005a) above 4,300 feet amsl (BLM 2006b). Ute ladies'-tresses populations require recurrent disturbance, such as seasonal flooding, grazing, or mowing for establishment and persistence and often occur in recently created riparian habitats such as sand bars and backwaters (USFWS 1995a).

There are currently no known occurrences of the species within the MBPA. However, the MBPA is included within the range of the species because it is known to occur in Duchesne and Uintah Counties

[6] UDOGM well count includes wells in the following categories: shut-in, producing, drilling, abandoned, temporarily abandoned, active, inactive, location abandoned, and drilling operations suspended.

(Fertig et al. 2005, UNPS 2007, UDWR 2007). Potential habitats within the Project Area include riparian areas, alluvial cobbles or shingles backed by native cottonwoods, and within portions of the Pariette Wetlands.

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

This chapter presents a discussion of the environmental impacts associated with Alternative D, as presented in **Chapter 2.0**. Analysis of environmental impacts in this chapter is confined to that associated with new disturbances for Alternative D. The alternative analyzed in this section includes the following:

- **Alternative D - Agency Preferred Alternative** is the agency preferred alternative, which was developed in response to comments received during the agency and public scoping period. It was designed to minimize the amount of new surface disturbance within the Pariette Wetlands ACEC, Level 1 and 2 Core Conservation Areas for *Sclerocactus* species, and other portions of the MBPA through the use of directional drilling technology on new and existing multi-well pads. Alternative D analyzes the impact of drilling up to 3,250 Green River oil wells and 2,500 vertical or directionally drilled deep gas wells.

4.2 THREATENED, ENDANGERED, CANDIDATE AND PROPOSED SPECIES

In general, construction and operational impacts on special status fish and wildlife species and their habitats would be similar to those for general vegetation communities and wildlife. However, these impacts can be more severe for special status plant, fish and wildlife species (including those listed as threatened or endangered under the ESA of 1973, as amended; BLM sensitive species; species proposed for listing; species of special concern; other USFWS or BLM species identified as unique or rare; other UDWR or UNHP species designated as unique or rare), if present, since the distribution and abundance of many of these species are limited in the MBPA and surrounding region. An adverse impact to special status species would be considered to occur if construction and/or operation of any component of the proposed project would cause substantial changes to the existing abundance, distribution, pollinators, or habitat value for a special status plant, fish or wildlife species.

The following sections describe the anticipated effects of various project components and activities associated with Alternative D on federally listed, proposed, and candidate species carried forward for evaluation. The magnitude and nature of effects resulting from implementation of the Alternative D is assessed for the species relative to existing conditions in terms of whether these effects are expected to appreciably reduce likelihood of species survival and recovery. Conclusions regarding the effects of the Alternative D on the species, as well as a determination of effect (***no effect; may affect, is not likely to adversely affect; may affect, is likely to adversely affect; is likely to jeopardize proposed species/adversely modify proposed critical habitat; and is not likely to result in a trend towards federal***

listing of the species) is presented in the conclusions and determination section at the end of the analysis for the species.

4.2.1 Fish and Wildlife

4.2.1.1 Western Yellow-billed Cuckoo

The Western yellow-billed cuckoo (WYBC) is an obligate riparian species that nests and forages in cottonwood-willow woodlands with a dense sub-canopy. While there is a low potential for the species to occur within the MBPA, their presence within the area cannot be entirely discounted. Riparian habitat that could be used by the WYBC occurs on the eastern edge of the MBPA along the Green River and within isolated portions of Pariette Draw.

The overall initial surface disturbance to Rocky Mountain Lower Montane Riparian Woodland and Shrubland vegetation, which serves as potential nesting and foraging habitat for cuckoo, would be approximately 1 acre. If development or production activities were to occur during the cuckoo's breeding season (March through July), direct impacts could result in loss of nests, eggs, or young, or the disruption of breeding activities for that season. The magnitude of potential impacts would be considerably minimized under Alternative D, as few new well pads would be constructed, the amount of new surface disturbance would be minimized through the increased use of multi-well pads and directional drilling technology, limited surface disturbance or well pad expansions would be allowed on federal lands within the Pariette Wetlands ACEC, and surface disturbance within riparian and 100-year floodplain habitats would be limited to the water collector well. No surface disturbance would occur within proposed critical habitat for the WYBC.

These habitat areas are located within the 100-year floodplain of Pariette Draw and the Green River in the extreme northeastern corner of the MBPA. Under existing regulations, guidelines, and ACEPMs, well pads and associated roads and pipelines would be located to avoid or minimize impacts in riparian areas and the 100-year floodplain of Pariette Draw and the Green River, and appropriate erosion control and revegetation measures would be employed.

Indirect impacts to the species include displacement due to increased human presence in the area and the associated increase in noise, traffic, and dust levels, and increased invasion of non-native plants into suitable habitat. Invasion of riparian habitats by aggressive non-native species, particularly tamarisk (Tamarix species), would adversely impact the species. Other potential indirect impacts to the species include decreased water quality and degradation of riparian vegetation, due to erosion and sedimentation associated with surface disturbance.

Determination for Western Yellow-Billed Cuckoo

Because implementation of Alternative D would directly impact only 1 acre of suitable WYBC habitat, it constitutes a negligible percentage of suitable habitats available throughout the range of this species. In addition, the mitigation measures listed below would require WYBC surveys before any surface disturbance or drilling occurs in WYBC habitat during the breeding and nesting season. Therefore, implementation of Alternative D ***is not likely to adversely affect*** the threatened WYBC.

Mitigation Measures for Western Yellow-Billed Cuckoo

- Prior to any surface-disturbing activity within WYBC habitat during the June 1 through August 1 breeding season, surveys would be conducted by a qualified biologist to determine if breeding or nesting WYBC are present. If WYBC are present, surface disturbance or drilling activity would be precluded within one mile of occupied habitat to avoid disturbance to breeding birds or nests.

4.2.1.2 Colorado River Fish Species

Alternative D activities would result in direct and indirect impacts to Colorado River endangered fish species (i.e., bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker) and their habitats. The principal impacts to these species likely to be associated with Alternative D include: (1) flow depletion due to project-related water use; (2) increased sedimentation of the Green River; and (3) an increased risk of accidental spills of pollutants such as natural-gas condensate and oil into the Green River or its tributaries. The magnitude of these impacts to Colorado River endangered fish species would depend on a number of factors, including the type and duration of disturbance, time of year, and implementation of recommended and required mitigation measures. The severity of these impacts to Colorado River endangered fish species would depend on a number of factors, including the type and duration of disturbance, time of year, and implementation of recommended and required mitigation measures.

Water depletion also may affect aquatic habitats and fisheries resources within these watersheds. Water requirements for drilling, hydrostatic testing, dust abatement, and other project activities would be acquired from permitted sources. These sources may include direct withdrawals from the Green River, Pariette Draw, municipal sources, and local supply wells. Existing authorized water usage would directly and indirectly consume water from the Green River and ultimately cause reductions in flow within the Colorado River Basin.

The Colorado River fish are affected by activities that deplete or degrade the flow of downstream waters into the Upper Colorado River Basin (USFWS 1987). In addition to reducing the quantity of water with sufficient quality in a specific location, water depletions can also reduce a river's ability to create and maintain the physical habitat (areas inhabited by, or potentially inhabitable by, special status fish for use in spawning, nursery, feeding, and rearing, or access to these habitats) and the biological environment (food supply, predation, and competition). Water depletions can also contribute to alterations in flow regimes that favor non-native fish that compete with native fish species for resources.

As outlined in **Section 2.3.8**, it is estimated that total water use in drilling and completion of up to 5,750 wells under Alternative D would be approximately 1,150 acre-feet of water annually. Additionally, it is estimated that Newfield would use approximately 36 acre-feet of water per year for dust abatement during project operations and up to 2,738 acre-feet per year for water-flooding operations. Thus, total water use under Alternative D would average approximately 2,774 acre-feet annually over the 20- to 30-year construction and operational period.

On January 22, 1988, a Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (Recovery Program) was initiated to address depletion and other impacts to the Colorado River fish. Any water depletions from tributary waters within the Colorado River drainage are considered to "jeopardize the continued existence" of these fish under this Recovery Program. A Section 7 agreement was implemented on October 15, 1993, by Recovery Program participants to further define and clarify objectives of the recovery process as stated in the Recovery Program. Incorporated into this agreement was the Recovery Implementation Program Recovery Action Plan (RIPRAP). The RIPRAP identified actions currently believed to be required to recover the Colorado River fish most expeditiously. Included in the RIPRAP was the requirement that a one-time depletion fee would be paid to help support the Recovery Program for all non-historical water depletions from the Upper Colorado River Basin. These depletion fees were intended to be a Reasonable and Prudent Alternative to avoid jeopardy to the endangered Colorado River fish by depletions to the Upper Colorado River Basin. In 1995, USFWS eliminated these water depletion fees for water depletions from the Upper Colorado River Basin of 100 acre-feet per year or less (USFWS 1995b).

Newfield currently has secured water rights for up to 5,106 acre-feet per year. Of this volume, 324 acre-feet are from water sources considered historic depletions under the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (USFWS 1987). Section 7 consultation was completed for all historic depletions in 1993 (USFWS 1993). As part of this consultation, it was determined that historic depletions, regardless of size, do not pay a depletion fee to the Recovery Program. Newfield's additional water sources (WR 41-3530; WR 47-1802; WR 47-1804) are not considered historic depletions and Section 7 consultation with the USFWS is required prior to use of these sources. To date, three consultations have been completed for water depletions associated with oil and gas development projects in the MBPA. Currently, a total annual volume of 3,328 acre-feet has been authorized through USWFS consultations (refer to **Table 2.3.8.5-1**). Water supply sources used under these previous consultations, plus the historic water rights, makes a total of 3,652 acre-feet of water available for this Project. The additional 273 acre-feet of water needed under Alternative D would require additional consultation.

Potential impacts to Colorado River fish from construction and operation of the proposed water collection station would include short-term disturbance of about 1 acre of floodplain habitat, which could result in erosion and sediment yield. Impingement at the intakes is not anticipated as a result of the use of screening. Hydrocarbons located at the nearby (but outside of the floodplain) water processing station would be limited to produced natural gas or NGL that would be used as a fuel source to power the 300 600 hp generator associated with the processing station. Therefore, there is a low risk of leaks or spills from hydrocarbons associated with the water collection station to impact fish.

Implementation of Alternative D could also degrade USFWS-designated critical habitat for Colorado River fish in the Green River by increasing erosion and sediment yield. Sediment deposition may bury and suffocate fish eggs and larvae affecting spawning and rearing, while reduced visibility created by sediment load may inhibit the ability of fish to see prey, impacting feeding behavior (USEPA 2003). Physiological impacts, such as gill clogging and the ingestion of large quantities of sediment, could also cause illness, reduced growth, and eventual death (USEPA 2003). Due to existing surface disturbance, ongoing projects, and poor reclamation success of previously disturbed areas within the MBPA and surrounding region, increased erosion and subsequent sediment yield are likely to occur within these watersheds.

Sediment could be delivered to several perennial streams, riparian habitats, and small, ephemeral drainages (i.e., Castle Peak Draw, Wells Draw, Big Wash, Sheep Wash) within the MBPA. Conservatively, assuming that all sediment delivered to Pariette Draw and other drainages within the MBPA is eventually transported to the Green River, Alternative D would increase sediment loading to the Green River by about 66 tons annually, or by approximately 0.001 percent in the short-term.

Activities within or adjacent to the 100-year floodplains of Pariette Draw and the Green River, or within drainages leading to these watercourses, may increase the potential for a release of contaminants into these areas. Leaks or spills of contaminants may lead to habitat degradation and mortality of fish. The risk of acute or chronic toxicity to endangered fish in the Green River in the event of a natural-gas condensate spill would depend on the location of the spill relative to the main stem Green River. Natural gas condensate contains a variety of lightweight hydrocarbons, of which the most toxic to aquatic biota is the aromatic hydrocarbon fraction (benzene, ethylbenzene, toluene, xylenes). These account for less than 0.5 percent of the volume of condensate (BLM 2005b). Natural-gas condensate is highly volatile and likely to evaporate within approximately 8 hours of spilling (BLM 2005b). Thus, spills occurring in close proximity to the Green River, or in streams with flow rates that would deliver condensate to the Green River prior to evaporation, would pose a risk of exposing Colorado River fish to potentially lethal levels of toxic substances.

Under Alternative D, pipelines would cross ephemeral streams at approximately 1,046 locations within the MBPA. Because the crude oil extracted within the MBPA is solid within the temperature range of the area's climate, oil would not pose a risk of acute toxicity for Colorado River endangered fish in the event of an accidental spill. A catastrophic spill of a 400-barrel (16,800-gallon) condensate tank within the 100-year floodplain of the Green River, while highly unlikely, would have a high probability of producing acutely toxic concentrations of condensate in the Green River, and therefore is considered a possible adverse impact to Colorado River fish. A spill from a condensate tank within the Green River floodplain would constitute the overall worst case scenario under the Proposed Action and would likely result in acute toxicity at some flow levels and an adverse impact to designated critical habitat.

ACPEMs and BMPs for the site-specific use of buried pipelines and centralized water and condensate tank facilities (where they were determined to be appropriate at the site-specific level) would reduce the risk of spills from pipelines and tanks. Burying pipelines would reduce the risk of accidental puncture of pipelines, and central tanks batteries could be located outside the floodplain, greatly reducing the risk of spills affecting the Green River. Surface disturbance in riparian habitats and the floodplain would be limited to the water collector well. Therefore, the potential for a release of contaminants into the main stem of the Green River, and subsequent increased risk of acute or chronic toxicity to endangered fish in the Green River in the event of a natural-gas condensate spill, is considered to be low. The proposed mitigation measures described below would preclude the development of wells in the floodplain.

Determination for Colorado River System Threatened and Endangered Fish

Based on the projected water depletions and the increase in yields of the Green River, implementation of Alternative D ***may affect, is likely to adversely affect*** the listed Colorado River fish species, bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker and their habitat. The loss or "take" of an unknown number of individual fish would be anticipated. The potential also exists that portions of the designated critical habitat for these species may be adversely modified.

Mitigation Measures for Colorado River System Threatened and Endangered Fish

- Newfield and its contractors would locate, handle, and store hazardous substances in locations that would prevent accidental spill or delivery to the Green River or its tributaries.

- Natural gas-condensate pipelines that cross mapped 100-year floodplain, mapped riparian, or wetland areas would be routinely pigged and would have emergency shutoff valves located immediately outside the floodplain.

- Natural gas pipelines that cross perennial, intermittent, and ephemeral stream channels would be buried below the predicted scour depth for an equivalent flood event. The construction requirements for each type of crossing would be determined on a site-specific basis and would consider the technical guidance of the document entitled, "Hydraulic Considerations for Pipeline Crossings of Stream Crossings," which is found in Appendix B of the Vernal RMP (BLM 2008b).

- Natural gas pipelines that cross perennial, intermittent, and ephemeral stream channels would have automatic shutoff valves directly beyond the area at risk of flooding to reduce the magnitude of contamination in the event of an accidental pipeline break.

- Natural gas pipelines that cross perennial, intermittent, and ephemeral stream channels would be buried at least 5 feet below the channel bottom.

- With the exception of the water collector well, wells proposed within the Green River's 100-year floodplain would be relocated to non-floodplain areas or drilled directionally from beyond the floodplain.

- Wells proposed in all 100-year floodplains within 3 miles of the Green River would use measures including the use of closed-loop drilling methods, berming, and secondary containment of all tanks and pits, as well as drilling during non-flood prone seasons.

- All applicable BLM-committed Conservation Measures for Colorado River fishes, as described in Appendix L of the Vernal RMP (BLM 2008b), would be used as needed to mitigate potential impacts to endangered and sensitive fishes and their habitat (see **Attachment G** for a summary of these measures).

- To avoid entrainment, water would be pumped from an off-channel location - one that does not connect to the river during high spring flows. An infiltration gallery constructed in a location approved by USFWS would be used.

- If the pump head is located in the river channel the following stipulations would apply:

    - The pump would not be situated in a low-flow or no-flow area, because these habitats tend to concentrate larval fishes.
    - The amount of pumping would be limited, to the greatest extent possible, during that period of the year when larval fish may be present (April 1- August 31).
    - The amount of pumping would be limited, to the greatest extent possible, during the midnight hours (10 PM to 2 AM), because larval drift studies indicate that this is the period of greatest daily activity. Dusk is the preferred pumping time, because larval drift abundance is lowest during this time.
    - All pump intakes would be screened with 3/32-inch mesh material.
    - Approach velocities for intake structures would follow the National Marine Fisheries and USFWS document "Fish Screening Criteria for Anadromous Salmonids." For projects with an in-stream intake that operate in stream reaches

where larval fish may be present, the approach velocity would not exceed 0.33 feet per second.

  - Any fish impinged on the intake screen or entrained into irrigation canals would be reported to the USFWS (801-975-3330) or to the UDWR Northeastern Region, located at 318 North Vernal Avenue, Vernal, UT 84078 (435-781-9453).

- For all tributaries that drain directly to Pariette Draw or directly to the Green River, roads and well pads would be set back a minimum of 300 feet from the active stream channel (average 3-feet wide or greater without an associated riparian zone), unless site specific analysis demonstrates that: 1) the proposed well or road could be placed on higher terrain above the 100-year floodplain, 2) the 100-year floodplain can be demonstrated to be narrower than 200 feet in the area proposed for well location; or 3) the well pad or road can be increased in height to avoid a predicted over-topping 50-year flood. In these situations, the well pad or road would not be placed closer than 100 feet from the stream channel.

- All new stream crossings would be kept to a minimum. In the case of an unavoidable stream crossing, culverts would be designed and constructed to allow fish passage. All stream crossings would be designed and constructed to keep impacts to riparian and aquatic habitat to a minimum.

- Appropriate BMPs needed to mitigate water impacts anticipated to occur from surface-disturbing activities would be identified during the onsite process and may include, but would not be limited to, proper culvert design, installation of energy dissipation devices, proper site selection (avoidance of steep slopes, riparian areas, wetlands, areas subject to severe soil movement, and areas of shallow groundwater and natural watercourses), and using closed-loop drilling.

4.2.1.3 Greater Sage-Grouse

Oil and gas development can cause sage-grouse populations to decline; however, the specific reasons for declines are still unknown (Braun et al. 2002; Connelly et al. 2000). The primary impacts of development to sage-grouse include direct habitat loss from well pad, road, pipeline and facility construction, as well as avoidance and displacement due to increased human activity and habitat fragmentation. Braun et al. (2002) maintain that oil and gas development may have negative short-term (site construction, drilling, and completion), and long-term (road development) effects.

Numerous citations have linked oil and gas development to declines in sage-grouse populations. For example, Holloran (2005), Doherty et al. (2008), Walker et al. (2007), Lyon and Anderson (2003), and Crompton and Mitchell (2005) have linked population reductions in response to oil and gas development. Sage-grouse exhibit fidelity to traditional winter use areas, and surface disturbance and human activity in these areas may cause sage-grouse to displace to less adjacent habitats, which may not have the desired vegetative cover and/or may leave the species more susceptible to predation.

Additionally, various studies have determined that sage-grouse are affected by human activity (Braun 1986; Lyon and Anderson 2003; Remington and Braun 1991). These studies have determined that hens nested farther away from leks in areas where human disturbance occurred, and that nesting initiation rates were also lower. In addition, it was also determined that male attendance at leks was lower when human activity occurred within 2 miles. The UDWR identified one lek, known as the Myton Bench – Wells Draw lek, near the southwestern portion of the MBPA, approximately 0.5 miles from the nearest proposed development. This lek was last reported as active during the 1999 season, and has since been eliminated and replaced by project facilities. Therefore, there would be no impacts to leks within the MBPA from implementation of Alternative D.

The UDWR has not yet identified priority habitat with a consistent methodology. Although most of the habitat within the MBPA is marginal for sage-grouse breeding and nesting, it is possible that a few individual sage-grouse occasionally use portions of the MBPA. Approximately 2,185 acres of sagebrush shrubland, which may provide marginal habitat for sage-grouse, would be disturbed from activities related to Alternative D. While it is likely that some sage-grouse use portions of the MBPA on a limited basis, there is no PPH for sage-grouse within the MBPA. The nearest PPH is located approximately 0.6 mile south of the MBPA. Additionally, there are no habitats designated as occupied, brood rearing, or winter habitats for sage-grouse within the MBPA. Project-related noise (e.g., increased volumes or types of noise from construction, drilling, and production equipment, changes in ambient tones or tonal noises, and repetitive low frequency noise emanating from production equipment such as compressor stations) may affect sage-grouse that occasionally occupy the MBPA. Sage-grouse could be temporarily displaced by noise and other human activities until activities are completed.

Determination for Greater Sage-grouse

Based on the information above, implementation of Alternative D may impact individual sage-grouse, but ***is not likely to result in a trend towards federal listing of the species.***

4.2.2 Plants

4.2.2.1 Uinta Basin Hookless Cactus and Pariette Cactus

As previously discussed in Chapter 2, one of the primary objectives of Alternative D is to reduce surface disturbance within *Sclerocactus* habitat and specifically, within the Upper and Lower Pariette Core Conservation Areas. However, for analysis purposes, the Alternative evaluated the most conservative (i.e., worst-case) scenario. Under this conservative scenario, implementation of Alternative D could directly result in the disturbance of approximately 4,295 acres of potential habitat for *Sclerocactus* species within the MBPA, which represents approximately 1 percent of the total potential habitat for *Sclerocactus* species across their entire range. Following construction, approximately 2,201 acres (51 percent) of land associated with the construction of the well pads, access roads, and pipeline ROWs not needed for operation purposes would be reclaimed. If reclamation is successful, the long-term disturbance to *Sclerocactus* species' habitat under Alternative D would be reduced to approximately 2,094 acres.

Under Alternative D, no new surface disturbance or well pad expansions would occur within Level 1 Core Conservation Areas except as allowed under the FWS/Newfield Conservation, Restoration, and Mitigation Strategy for the Pariette and Uinta Basin Hookless Cactus (**Attachment F**). Per the strategy in Level 1 areas, there could be approximately 116 acres of new disturbance from limited well pad expansions and pipelines buried adjacent to existing roads and up to 20 acres of new disturbance from eight new well pads. In Level 2 areas, GIS calculations show conceptually mapped disturbance of approximately 210.8 acres of disturbance. Surface disturbance in Level 2 areas would be minimized to the greatest extent practicable by using existing infrastructure (i.e., access roads and pipelines) and directional drilling from multi-well pads that would either require the expansion of existing well pads or the construction of a limited number of new multi-well pads. Concentrated use of existing well pads would reduce fragmentation of *Sclerocactus* habitat. If reclamation is successful, the long-term disturbance to Level 1 and Level 2 Core Conservation Areas under Alternative D would be reduced to approximately 57 acres and 583 acres, respectively. Similarly, Alternative D's focused use of existing well pads would reduce the level of habitat fragmentation from new roads and pipeline corridors.

Indirect and dispersed direct effects to *Sclerocactus* species under Alternative D could include an increased potential for the invasion and establishment of noxious weed species. Invasion by non-native species is particularly problematic as they are capable of effective competition with native species for space, water, light, nutrients, and subsequent survival. Over time, the successful establishment of non-native species can choke out native vegetation and eventually dominate large areas. An increase in weedy annual grasses also increases the potential for fire by increasing the density and flammability of available fuels. Grasses are more flammable and establish in denser populations than woody and non-woody native vegetation.

Additional indirect construction-related impacts could include an increased potential for wind erosion of disturbed areas, creating airborne dust that could be transported into suitable habitat for these species. Airborne dust generated by vehicles could inhibit photosynthesis and transpiration in these species. Inhibited and reduced rates of photosynthesis could affect the rate of growth, the reproductive capacity of individual plants, and ultimately the ability of these individuals to persist in adjacent areas. Thompson et al. (1984) and Farmer (1993) have indicated that varying amounts of dust settling on vegetation can block stomata, increase leaf temperature, and reduce photosynthesis.

Other indirect impacts to Sclerocactus species could include impacts from the use of herbicides to control invasive plants in the MBPA, and possible reductions in pollination or seed dispersal from a larger road network that could result in isolation of populations due to habitat fragmentation and increased dust. Because Sclerocactus species require insect pollinators for successful reproduction (Tepedino et al. 2010), impacts to pollinator nesting and foraging habitats can negatively affect the cactus by reducing the diversity and abundance of pollinators, and, thereby, the plant's ability to successfully reproduce. Expansion of access roads also could also increase the risk of illegal collecting of Sclerocactus species.

Additional species-specific conservation measures for *Sclerocactus* species under Alternative D, include provisions to avoid all new surface disturbances to Level 1 Core Conservation Areas and to limit the disturbance to Level 2 Core Conservation Areas through the use of existing multi-well pads and roads, and increased use of directional drilling technology (**Section 2.1.2**). The proposed mitigation measures for *Sclerocactus* species are described below.

Determination for Uinta Basin Hookless Cactus and Pariette Cactus

Although these measures would minimize the impacts of the action to *Sclerocactus* species, larger landscape-level changes, such as increased habitat fragmentation and habitat loss, pollinator disturbance, changes in erosion and water runoff, and increased weed invasion, cannot be entirely negated. These disturbances could continue to negatively impact *Sclerocactus* species throughout the MBPA. An undetermined number of individual plants could be lost; therefore, implementation of Alternative D ***may affect, is likely to adversely affect*** the Uinta Basin hookless cactus and Pariette cactus and their habitats.

Mitigation Measures for Uinta Basin Hookless Cactus and Pariette Cactus

<u>Sclerocactus Surveys</u>

- Pre-project habitat assessments will be completed across 100% of the project disturbance area within potential habitat prior to any ground-disturbing activities to determine if suitable *Sclerocactus* habitat is present.

- Pre-construction *Sclerocactus* surveys will occur following the pre-project habitat assessments that identified any suitable habitat within the project area. These pre-construction surveys must follow U.S. Fish and Wildlife Service (USFWS) Utah Field Office Guidelines for Conducting and Reporting Botanical Inventories and Monitoring of Federally Listed, Proposed, and Candidate Plants. Surveys will be conducted in suitable habitat prior to initiation of project activities, at a time when the plant can be detected, and during appropriate flowering periods:

    - *Sclerocactus brevispinus* surveys must be conducted between March 15th and June 30th, unless an extension is provided in writing by the USFWS,
    - *Sclerocactus wetlandicus* surveys can be done any time of the year, provided there is no snow cover.

- *Sclerocactus* surveys will be conducted by a qualified botanist. Qualifications are defined in the USFWS Utah Field Office Guidelines for Conducting and Reporting Botanical Inventories and Monitoring of Federally Listed, Proposed and Candidate Plants, http://www.fws.gov/utahfieldoffice/SurveyorInfo.html. Qualified botanists must also attend the USFWS Uinta Basin Rare Plant Workshop, http://www.fws.gov/utahfieldoffice/UBRarePlants.html.

- *Sclerocactus* surveys for access roads, buried pipelines, well pads, and other facilities requiring removal of vegetation (e.g., compressor stations) will include the project area and/or right-of-way (ROW), and 300 feet from the edges of the project disturbance and/or ROW.

- *Sclerocactus* surveys for surface pipelines placed within an existing road ROW, and within 10 feet from the edge of the disturbed surface of the road, will include the ROW and 50 feet from the edge of the ROW on the pipeline side of the road.

- *Sclerocactus* surveys for cross-country surface pipelines (pipelines over 10 feet from a road), where the pipeline will be laid by hand with minimal disturbance and no vehicle use, will include the ROW, and 50 feet from the edges of both sides of the ROW.

- Surveys for all other cross-country surface pipelines (vehicles or equipment used, not laid out by hand) will include the ROW and 300 feet from the edges of both sides of the ROW.

- *Sclerocactus* surveys will not be necessary when pipelines are buried in existing roads.

- Initial pre-disturbance 100% clearance surveys will be conducted following standard methodology and will be valid for a period of 4 years.

- If more than 4 years pass between the original surveys and construction, a new 1 00% clearance survey will be required.

- If construction is to occur within the 4 year window, an additional, reduced-effort "spot check" survey will be conducted following the below methodology in the year of project construction.

- *Sclerocactus* Spot Check Survey Methods
    - Spot checks will be conducted by qualified individuals according to BLM and Service standards for plant surveyors (i.e. attendance at Uinta Basin Rare Plant Workshop, qualifying education and experience).
    - Spot check surveys will occur during the year of construction.
    - Timing limitations for spot check surveys will follow existing protocols for regular surveys:
        - *S. brevispinus*: March 15 through June 30 unless extended by prior written approval by the Service;
        - *S. wetlandicus*: During any time of year with no snow cover.
    - Within 30 feet (10 meters) of the perimeter of the previous survey, spot check surveys will occur at a moderate intensity (survey lines spaced 10 feet or so apart at a moderately slow speed; this can be done via a meander survey method) except in the following locations:
        - Original survey areas that are within 300 feet and downslope of known plant locations, where seeds are likely to disperse during rain events. Locations meeting this criteria will require 100% clearance surveys.
        - Areas immediately adjacent to ant mounds/colonies that fall within the original 1OO% clearance survey boundary. Another known mechanism for *Sclerocactus* seed dispersal is harvester ants, so the area immediately adjacent to active and inactive ant mounds (approximate 10 foot diameter) should be surveyed following standard survey protocols for new germinants of *Sclerocactus*.
    - Surveys will be completed prior to any ground disturbing activities. Operators may not proceed on the basis of a preliminary negative spot check survey.
    - Biological reports of the spot check survey will be submitted to the BLM authorizing official, and the authorizing official will provide written approval to the operator to proceed with the project.
    - Spot check biological reports will also be submitted to the Service so that the Service may evaluate the efficacy of these survey methods.
    - The BLM authorizing official can halt construction as necessary based on new plant location information obtained from sources other than the operator or the contractor hired by the operator.

General Mitigation Measures

- Existing surface pipelines located closer than 50 feet to known *Sclerocactus* individuals will be secured in place to prevent pipeline movement (and in accordance with Core Area 1 and Core Area 2 conservation recommendations, as outlined below).

- Only water (no chemicals, reclaimed production water or oil field brine) will be used for dust abatement measures within cactus habitat.

- Dust abatement will be employed in potential *Sclerocactus* habitat over the life of the project during the time of the year when *Sclerocactus* species are most vulnerable to dust-related impacts (March through August).

- Design project infrastructure to minimize impacts within potential habitat:
  - Reduce well pad size to the minimum needed, without compromising safety;
  - Limit new access routes created by the project;
  - Roads and utilities should share common ROWs where possible;
  - Reduce width of ROWs and minimize the depth of excavation needed for the road bed or use the natural ground surface for the road within habitat, where feasible,;
  - Place signing to limit off-road travel in sensitive areas;
  - Stay on designated routes and other cleared/approved areas;

- Within occupied habitat, project infrastructure will be designed to avoid direct disturbance and minimize indirect impacts to populations and to individual plants:
  - Follow the above recommendations for project design within potential habitats;
  - Designs will avoid concentrating water flows or sediments into occupied habitat;
  - Place produced oil, water, or condensate tanks in centralized locations, away from occupied habitat,

- Where new surface disturbance directly affects *Sclerocactus* (cacti are directly removed), a monetary amount will be contributed to the Sclerocactus Mitigation Fund to aid in the recovery of *Sclerocactus* species impacted by the project. These contributions are in addition to payments requested for indirect effects to cacti. Contributions will be negotiated between the Operator and the USFWS based on the number of cacti directly impacted and in relation to the USFWS' current management guidelines for *Sclerocactus*. Funds will be paid to:

  Sclerocactus Mitigation Fund
  Michelle Olson, Manager
  Impact-Directed Environmental Accounts
  National Fish and Wildlife Foundation
  1133 Fifteenth Street NW, Suite 1100
  Washington, DC 20005

- All applicable surface stipulations from Appendix K and Fluid Minerals BMPs from Appendix R of the Vernal RMP (BLM 2008b) would be implemented (see **Attachment G** for a summary of these measures).

4.2.2.2 Ute Ladies'-tresses

There are no documented occurrences of Ute ladies'-tresses in the MBPA. Habitat for the Ute ladies'-tresses in the MBPA is generally confined to portions of the Pariette Wetlands. While the presence of wetlands is an important habitat quality for this species, the wetland vegetative cover includes open water and greasewood flats that do not represent suitable habitat for Ute ladies'-tresses. Direct disturbance to potential habitat for this species is unlikely, because no disturbance to wetlands or riparian areas in the Pariette ACEC is expected to occur under implementation of Alternative D. For the same reasons, the potential for occurrence of indirect and dispersed direct effects to this species from Alternative D would be unlikely to occur.

The species-specific conservation measures for Ute ladies'-tresses include provisions to avoid occupied habitat, to employ the use of spatial buffers between surface activities and known populations of plants, and to monitor the effectiveness of these measures. The proposed mitigation measures for Ute ladies'-tresses are described below.

Determination for Ute Ladies'-tresses

No loss of individual plants is anticipated through implementation of Alternative D, nor is Alternative D anticipated to impact suitable habitat for this species. Therefore, Alternative D ***is not likely to adversely affect*** the Ute ladies'-tresses.

Mitigation Measures for Ute Ladies'-tresses

- All applicable surface stipulations from Appendix K and Fluid Minerals BMPs from Appendix R of the Vernal RMP (BLM 2008b) would be implemented (see **Attachment G** for a summary of these measures). .

5.0 CUMULATIVE IMPACTS

5.1 INTRODUCTION

This section analyzes the cumulative impacts to specific resource values and uses that could occur from implementation of Alternative D, in conjunction with other impacts from past, ongoing, and reasonably foreseeable future actions. In addition to the evaluation of direct impacts, NEPA regulations require an assessment of cumulative impacts (40 C.F.R § 1508.7, 1508.25). CEQ regulations implementing NEPA define a cumulative impact as:

> "... The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

The following sections identify the time frame for effects; the past, present, and reasonably foreseeable future projects to be analyzed; and the cumulative impacts for each resource. The primary human influences in the area have been oil and gas development, historic and current Gilsonite mining, and livestock grazing. The compilation of these actions provides the basis for estimating future environmental changes that may affect the extent and quality of the natural and human environment. **Figure 5.1-1 (Attachment 1)** shows the locations of past, present, and reasonably foreseeable future actions included in the general cumulative effects area for oil and gas field development projects.

The geographic scope of each specific Cumulative Impact Analysis Area (CIAA) varies by resource and is larger for resources that are mobile or migrate, as compared to those that are stationary. The CIAA for many of the resources discussed in this section includes the watersheds that intersect the MBPA. For some resources, the CIAA is smaller due to the geographically confined nature of cumulative impacts (e.g., areas of special designation), while for others the CIAA is much larger and includes both Duchesne and Uintah Counties. **Table 5.1-1** identifies the CIAAs for individual resources and resource issues, along with the rationale for the selection of each area. **Figure 5.1-2 (Attachment 1)** depicts each of the resource specific CIAAs within the greater cumulative impact area for the EIS.

In general, the timeframe of the analysis is the 41-to 51-year LOP anticipated under Alternative D. However, the timeframe of cumulative impacts may vary from one resource value or use to another, depending on variations in the duration of different actions.

Although much of this analysis focuses on adverse cumulative impacts, cumulative impacts may also be beneficial. For example, there are significant positive cumulative economic effects of oil and gas development, including additional employment opportunities in the region, additional tax revenues to local governments, and increased royalties to the federal government.

TABLE 5.1-1
CUMULATIVE IMPACT ANALYSIS AREAS

Resource	Cumulative Impacts Analysis Area	Study Area Rationale
Special Status Plant, Fish, and Wildlife Species	Extent of Potential Habitat for the Uinta Basin hookless cactus and Pariette cactus; all watersheds within the MBPA for all other	Only activities occurring within potential habitat or near individual special status plant, fish, and wildlife

Resource	Cumulative Impacts Analysis Area	Study Area Rationale
	special status plant, fish, and wildlife species	species would contribute to impacts.

5.2 SPECIAL STATUS SPECIES AND STATE SPECIES OF CONCERN

The CIAA for special status plant, fish and wildlife species (including those listed as threatened or endangered under the ESA, as amended; or species proposed for listing; and excluding Uinta Basin hookless cactus and Pariette cactus) is defined as the spatial boundary all the watersheds that are contained within or intersect the MBPA (refer to **Table 5.1-1**).

5.2.1 Special Status Fish and Wildlife Species

Cumulative impacts to special status fish and wildlife species as a result of past, present and reasonable foreseeable surface disturbance resulting from oil and gas activity would include reduction of wildlife habitat and habitat fragmentation, disruption of seasonal patterns and migration routes, displacement of individual wildlife species, increases in the potential for vehicle and wildlife collisions, and could potentially contribute to harassment and poaching of wildlife species Given ongoing habitat loss and sensitivity to disturbance, special status species would likely be more susceptible to the impacts associated with oil and gas development when combined with other past, present, and reasonably foreseeable actions. However, on BLM-managed lands, surveys are typically required in areas where there are potential or known habitats of threatened, endangered, or other special designation species. These surveys would help determine the presence of any special status fish and wildlife species or the extent of their habitat. Protective measures generally would be taken for any BLM-approved activities to avoid or minimize direct disturbance in these crucial areas. Given the status of the Uinta Basin hookless cactus, Pariette cactus, and Colorado River endangered fish species, cumulative impacts for these species may be more pronounced than those for other special status plant, fish, and wildlife species.

5.2.1.1 Colorado River Fish Species, Including Colorado Pikeminnow, Razorback Sucker, Humpback Chub, Bonytail Chub, Bluehead Sucker, Flannelmouth Sucker, and Roundtail Chub

The Colorado River fish species (i.e., Colorado pikeminnow, razorback sucker, humpback chub, bonytail chub, bluehead sucker, flannelmouth sucker, and roundtail chub) would be impacted by activities that deplete or degrade the flow of downstream waters of the Upper Colorado River Basin. Portions of the Green River that occur within the CIAA provide habitat elements required by the Colorado River endangered fish. Cumulative impacts associated with Alternative D, in combination with impacts linked with other oil and gas development, livestock grazing, recreational activities, wildlife habitat management, and other land uses within the CIAA, would cumulatively reduce the quality and quantity of aquatic habitat for Colorado River endangered fish species.

Implementation of Alternative D, combined with other past, present, and reasonably foreseeable activities in the CIAA, could also result in the adverse modification of designated critical habitat for the Colorado River fish in the Green River by increasing erosion and sediment yield. Increased sediment loading from surface-disturbing activities could lead to slightly higher temperatures in Pariette Draw, which could have an adverse cumulative effect on fisheries and other aquatic species. Sediment deposition may bury and suffocate fish eggs and larvae, which may affect spawning and rearing. In addition, reduced visibility created by sediment loading may inhibit the ability of fish to see prey, which could impact feeding behavior (USEPA 2003). Physiological impacts, such as gill clogging and the ingestion of large quantities of sediment, could cause illness, reduced growth, and eventual death (USEPA 2003). Due to existing surface disturbance, ongoing projects, and poor reclamation success of previously disturbed areas within the MBPA and surrounding region, increased cumulative erosion and subsequent sediment yield would likely occur within these watersheds.

The total sediment yield associated with the Alternative D would be: approximately 24.9 tons/year existing condition, approximately 66.4 tons/year during construction, and approximately 34.1 tons/year during production (**Attachment C**). Annual sediment loading in the Green River at Ouray, Utah, is estimated at 6.8 million tons. Therefore, implementation of Alternative D would contribute to this total by a fraction of a percent, which would be considered negligible from a hydrologic standpoint. However, in the context of cumulative effects, the sediment loading contributions from this project, when combined with other oil and gas projects, livestock grazing, wildlife habitat management, and recreational activities, have a potential to substantially increase sediment loading in the Green River.

Colorado River fish species are also affected by activities that deplete the flow of downstream waters into the Upper Colorado River Basin (USFWS 1987). Depletion from the proposed project, combined with depletions from other oil and gas projects, ranching, commercial, and residential water use, has the potential to substantially reduce flow in the Upper Colorado River Basin. In addition to reducing the quantity of water with sufficient quality in a specific location, water depletions can also reduce a river's ability to create and maintain the physical habitat (areas inhabited by, or potentially inhabitable by, special status fish for use in spawning, nursery, feeding, and rearing, or access to these habitats) and the biological environment (food supply, predation, and competition).

The direct withdrawal of water from the Green River for drilling, dust abatement, water-flooding, ranching, commercial water use, and residential water use could also increase the potential to impinge fish on intake screens. In addition, the increased potential for release of natural gas condensate, hydrocarbons, or other toxic substances into the Green River or its tributaries from this project or other past, present, and reasonably foreseeable activities may cause direct mortality of individual fish.

5.2.1.2 Western Yellow-billed Cuckoo

Cumulative impacts to the WYBC, if present within the CIAA, could occur as a result of long-term surface disturbance of Rocky Mountain Lower Montane Riparian Woodland and Shrubland vegetation, which serves as potential nesting and foraging habitat for these species. Oil and gas development, livestock grazing, and recreational activities that occur during the breeding season for this species (March through July) can lead to direct impacts such as the loss of nests, eggs, or young, or the disruption of breeding activities for that season.

As shown in **Table 2.1.3-1,** surface disturbance associated with Alternative D, combined with all past, present, and reasonably foreseeable development, would cumulatively and incrementally affect the vegetation communities across the CIAA. Approximately 18,524 acres of land within the CIAA has been or will be disturbed by past, present, and future oil and gas activities. It is unknown what percentage of this total is Rocky Mountain Lower Montane Riparian Woodland and Shrubland vegetation. Similarly, it is difficult to quantify past, present and reasonably foreseeable surface disturbance impacts from other land uses such as livestock grazing and recreation. Nevertheless, the incremental contribution of the proposed project to the total surface disturbance of Rocky Mountain Lower Montane Riparian Woodland and Shrubland vegetation within the CIAA would be one (1) acre under Alternative D. While this surface disturbance acreage is relatively low, it must be considered as a contribution to cumulative impacts on this species.

5.2.1.3 Greater Sage-Grouse

While it is likely that some sage-grouse use portions of the Project Area on a limited basis, there are no habitats designated as occupied, brood rearing, or winter habitats for sage-grouse within the MBPA. Therefore, incremental impacts from the proposed project on sage-grouse within the CIAA would not be cumulatively considerable.

5.2.2 Special Status Plant Species

5.2.2.1 Uinta Basin Hookless Cactus and Pariette Cactus

The CIAA for the Uinta Basin hookless cactus and the Pariette cactus is the extent of potential habitat for the Uinta Basin hookless cactus and the Pariette cactus in the Vernal Planning Area. Direct cumulative impacts to these species could result from direct individual loss from trampling, temporary or permanent removal of aboveground cover, the temporary or permanent loss of suitable habitat, and soil compaction as a result of construction and operation activities, grazing, and recreational use. Indirect cumulative impacts include:

- Habitat fragmentation;
- Increased dust effects;
- Introduction and spread of invasive and noxious weed species;
- Temporary or permanent loss of suitable habitat; and
- Changes to the composition of the native vegetative community from surface disturbance activities such as oil and gas development, grazing, access road construction, seismic surveys, well staking, cultural resources surveys, biological surveys, and other human activities.

Changes in land use patterns or increased human encroachment could also adversely impact occupied and suitable habitats. In addition, recovery and reclamation of suitable habitats could be compounded by limiting reclamation conditions (e.g., drought).

According to the latest potential habitat polygon for the Uinta Basin hookless cactus and the Pariette cactus, the current area for potential habitat is approximately 537,564 acres, encompassing federal, state, Indian trust, and private land ownership. Relatively recent geographic data for the Uinta Basin hookless cactus and Pariette cactus includes over 18,400 point, representing approximately 40,528 individual cacti. These counts include both living and dead plants; however, the numbers do not include hybrids of the Uinta Basin hookless cactus and Pariette cactus, as the surveys occurred outside of the area where the two species overlap. Based on recent survey data (BLM and USFWS 2011) and extrapolation to unsurveyed suitable habitat, the total count for the Uinta Basin hookless cactus and Pariette cactus is approximately 50,000 individuals.

To estimate the approximate amount of surface disturbance that currently exists within the potential habitat polygon for the Uinta Basin hookless cactus and Pariette cactus, GIS data was obtained from UDOGM that shows approximately 5,161 oil and gas well locations within the habitat boundary (see **Table 5.2.2.1-1**). A very conservative estimate (i.e., worst-case estimate) of 5 acres of surface disturbance for each well (which includes associated roads and pipelines) was used to calculate the amount of acreage within the potential habitat polygon that is already disturbed by energy development. Based on these calculations, it is estimated that over 25,805 acres (5-percent) of habitat within the potential habitat polygon for the Uinta Basin hookless cactus and Pariette cactus is currently disturbed as a result of past and present oil and gas development. It is important to note, however, that this value is highly likely to be an overestimate, as the UDOGM data base does not account for multi-well pads. Therefore, while there are currently 5,161 wells within the *Sclerocactus* polygon area, it is likely that the number of well pads and associated surface disturbance is far less than estimated. Nonetheless, this BA assumes the most conservative estimate for analysis purposes.

Surface disturbance associated with the Alternative D, combined with all past, present, and reasonably foreseeable development, would cumulatively and incrementally affect potential habitat for Uinta Basin hookless cactus and Pariette cactus across the CIAA. Approximately 25,805 acres of potential habitat for these species within the CIAA has already been disturbed by past, present, and future oil and gas activities. The total surface disturbance to potential habitat for these species within the CIAA would be increased to approximately 30,100 acres under Alternative D (see **Table 5.2.2.1-1**). Disturbance would last for the duration of oil and gas development and production, until such time that reclamation has proven successful.

TABLE 5.2.2.1-1
SUMMARY OF IMPACTS TO UINTA BASIN HOOKLESS CACTUS AND PARIETTE CACTUS HABITAT WITHIN THE SCLEROCACTUS POTENTIAL HABITAT POLYGON

Habitat Type	Area (Acres)	Estimated Acreage of Disturbance from Past, Present, and Future Oil and Gas Activity*	Disturbance by Alternative (Acres)	Cumulative Total Disturbance (Acres)	Cumulative Disturbance Percentage (%)
Potential Habitat	**537,564**	**25,805**	**--**	**25,805**	**4.8**
Alternative D	--	25,805	4,295	30,100	5.6

*It is important to note that existing disturbance calculations based on UDOGM wells are likely a gross overestimate. The UDOGM data does not account for multiple wells being drilled from a single pad. Actual, existing surface disturbance is likely far lower than that identified in the table above.

Table 5.2.2.1-2 summarizes a range of cumulative surface disturbance within the Core Conservation Areas 1 and 2 in the Upper and Lower Pariette Bench regions based on both Newfield and USFWS existing disturbance calculation methodologies. The Upper and Lower Pariette Bench Core Conservation Areas occur entirely within the MBPA and Newfield's EDA #1 Project Area to the north and east of the MBPA.

As discussed in **Section 3.2.1.2.1**, the USFWS and Newfield have different methods of calculating surface disturbance. This discussion reflects both methodologies, and thus a range of existing disturbance within the Core Conservation Areas.

Under Newfield's assumptions, existing disturbance was determined using a custom dataset developed by Spatial Energy for Newfield based on aerial imagery analysis, which was flown annually for the MBPA between 2006 and 2013, and is referred to as "SPOT6" data. Additional information on existing disturbance was collected using a May 2014 "vendor" map that illustrates existing facilities and infrastructure within the MBPA. For portions of the Core Conservation Areas that did not have SPOT6 data or vendor map information, Newfield relied on sources such as as-built diagrams and plats from land surveyors that contain accurate information on existing facility locations and sizes.

As previously noted, to calculate existing disturbance the USFWS assumes 5 acres of disturbance for every well. A breakdown of existing wells[7] within the Core Conservation Areas according to UDOGM's data base as of January 16, 2015 is provided below:

	Core 1		**Core 2**	
	Upper Pariette	**Lower Pariette**	**Upper Pariette**	**Lower Pariette**
Existing Wells				
MBPA	132	30	399	33
EDA #1	26	29	53	5

Existing disturbance using each calculation methodology was then added to proposed disturbance under each alternative within this EIS, plus anticipated disturbance evaluated under Alternative C of Newfield's EDA #1 Environmental Assessment (EA), which was approved April 21, 2014 in the Record of Decision for EA # U&O-FY13-Q4-133. Disturbance acreages and percentages were evaluated by Core Conservation Area type (1 and 2) and by Upper and Lower Pariette. The lower range in **Table 5.2.2.1-2** summarizes cumulative disturbance based on Newfield calculations for existing disturbance. The higher range in **Table 5.2.2.1-2** summarizes cumulative disturbance based on USFWS calculation assumptions for existing disturbance.

[7] UDOGM well count includes wells in the following categories: shut-in, producing, drilling, abandoned, temporarily abandoned, active, inactive, location abandoned, and drilling operations suspended.

TABLE 5.2.2.1-2
CUMULATIVE DISTURBANCE RANGES WITHIN THE UPPER AND LOWER PARIETTE CORE CONSERVATION AREAS (LOWER END OF RANGE CALCULATED USING BLM METHOD FOR CALCULATING EXISTING DISTURBANCE, HIGHER END OF RANGE BASED ON USFWS METHOD FOR CALCULATING EXISTING DISTURBANCE BASED)

Alternative	Existing / Long-term / Total Disturbance	Level 1 Core Conservation Area Cumulative Disturbance				Level 2 Core Conservation Area Cumulative Disturbance			
		Upper Pariette[1]	Lower Pariette[2]	Total (acres) Upper and Lower Pariette	Total (%) Upper and Lower Pariette	Upper Pariette[3]	Lower Pariette[4]	Total (acres) Upper and Lower Pariette	Total (%) Upper and Lower Pariette
Alternative D[5]	**Existing (acres)**	206.05 - 660	112.3- 150	----	----	496.15 – 1,995	77.7 - 165	----	----
	Long-term (acres)	51.35	6.14	--	--	250.5	109.25	--	--
	EDA #1 Long-term (acres)	4.88	7.27			75.86	56.77	--	--
	Total (acres)	**262.28 – 716.23**	**125.71 – 163.41**	**387.99 – 879.64**	**10.4% - 23.5**	**822.51 – 2321.36**	**243.72 – 331.02**	**1,066 – 2,652.38**	**4.9% - 12.17%**
	Total (%)	**12.6% - 34.5%**	**7.6% - 9.85%**	--	--	**5.4% - 15.17%**	**3.7% - 5.09%**	--	--

[1]2078.45 acres in Upper Pariette Level 1 Core Conservation Area
[2]1658.19 acres in Lower Pariette Level 1 Core Conservation Area
[3]15297.56 in Upper Pariette Level 2 Core Conservation Area
[4]6495.48 in Lower Pariette Level 2 Core Conservation Area
[5] It is important to note that under Alternative D, new surface disturbance within the MBA include a BLM priority to keep total surface disturbance in the Level 2 areas below 5% of Level 2 core conservation areas.

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5.2.2.2 Ute Ladies'-tresses

Since habitat for the Ute Ladies'-tresses is generally limited to the convergence of the Green River and Pariette Draw and within portions of the Pariette Wetlands, its potential distribution within the CIAA is limited. Direct disturbance to potential habitat for this species is unlikely, because little disturbance to wetlands would likely occur under implementation of Alternative D. For the same reasons, the potential for occurrence of indirect and dispersed direct effects to this species would be unlikely to occur. Therefore, incremental impacts from the proposed Project on the Ute Ladies'-tresses within the CIAA are unlikely to be cumulatively considerable.

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ATTACHMENT 1 Maps and Figures

MAPS AND FIGURES

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Figure 1.1-1 Monument Butte Project Area

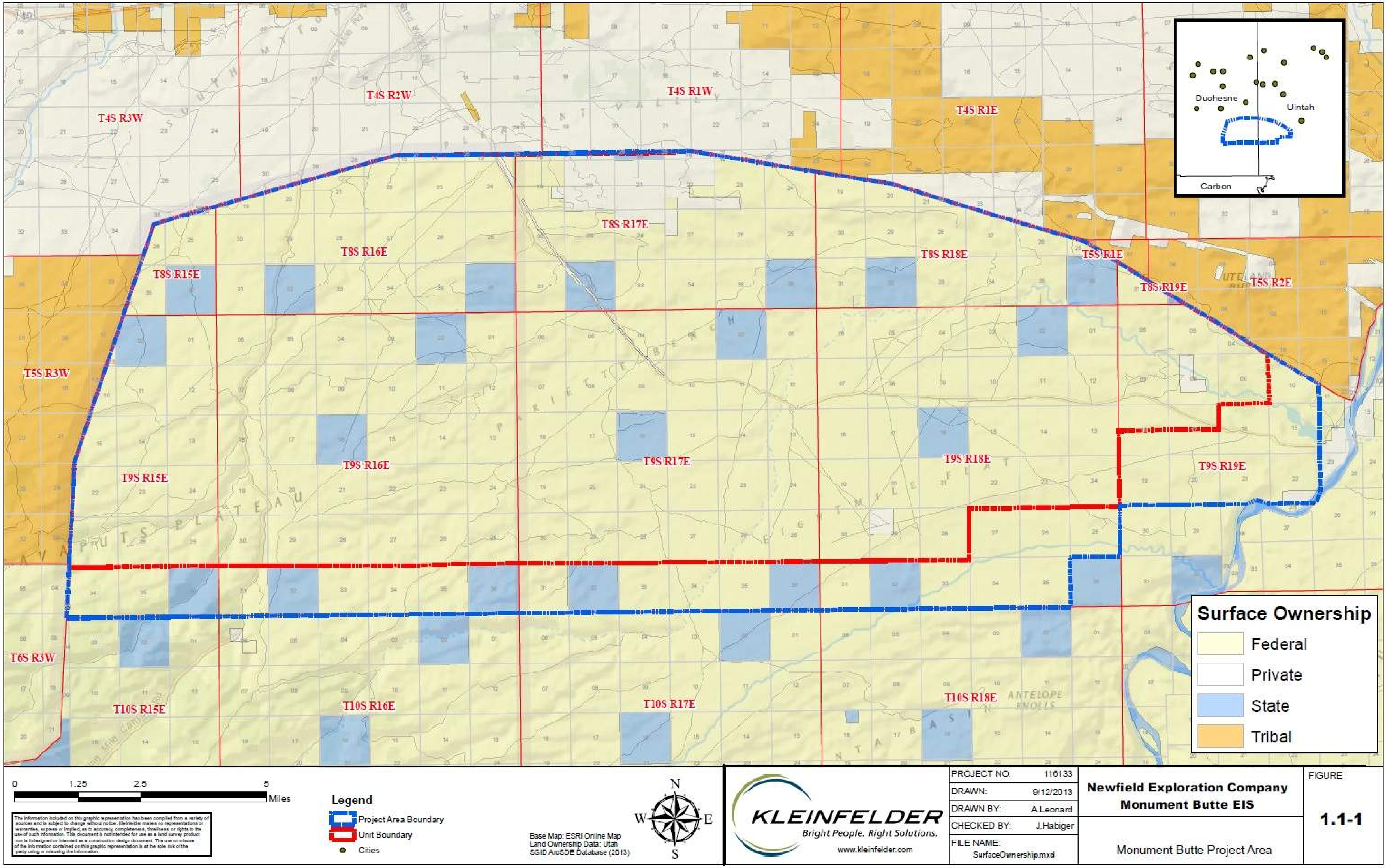

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Figure 2.2.2.1-1. Typical Single Well Pad Layout

Figure 2.2.2.1-1. Typical Single Well Pad Layout

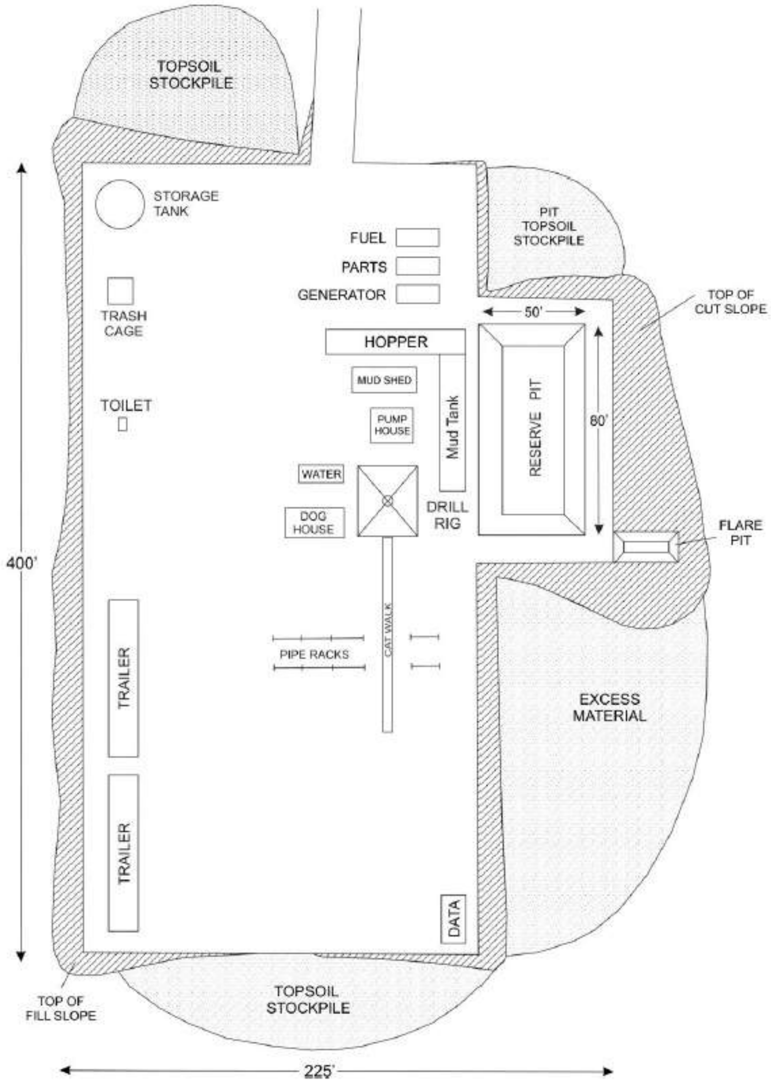
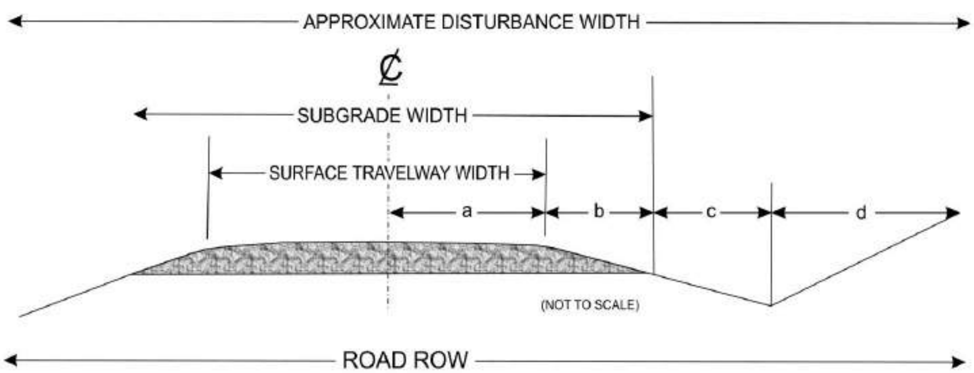


Figure 2.2.2.3-1. Typical Roadway Cross Section with Width Specifications

Figure 2.2.2.3-1. Typical Roadway Cross Section with Width Specifications



	Minimum Subgrade Width (ft.)	Minimum Surfaced Travelway Width (ft.)	a (ft.)	b (ft.)	c (ft.)	d (ft.)	Approximate Disturbance Width (ft.)	Total ROW Width (ft.)	Design Speed (mph)
Resource Road	16	12	6	2	4	8	40	50	15-30
Local Road	24	20	10	2	4	8	48	55	20-50
Collector Road	28	24	12	2	4	8	52	60	30-50

Figure 2.2.2.3-2. Typical Roadway Cross Section with Pipeline Installation Along Side Road

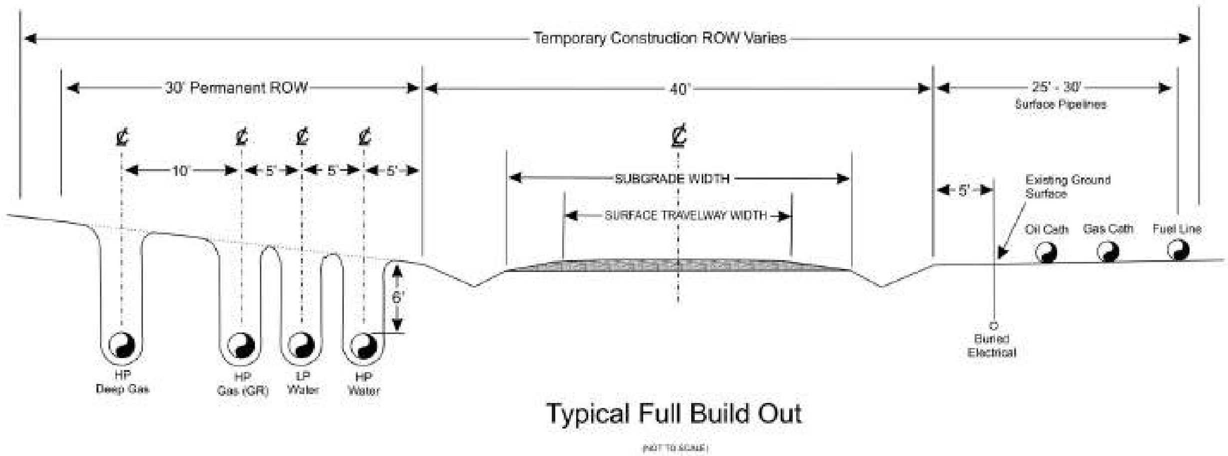


Figure 2.2.2.3-2 Typical Roadway Cross-section with Pipeline Installation Along Side Road.

Figure 2.2.2.4-1. Typical "Cross-Country" Pipeline Installation Scenarios with Width Specifications

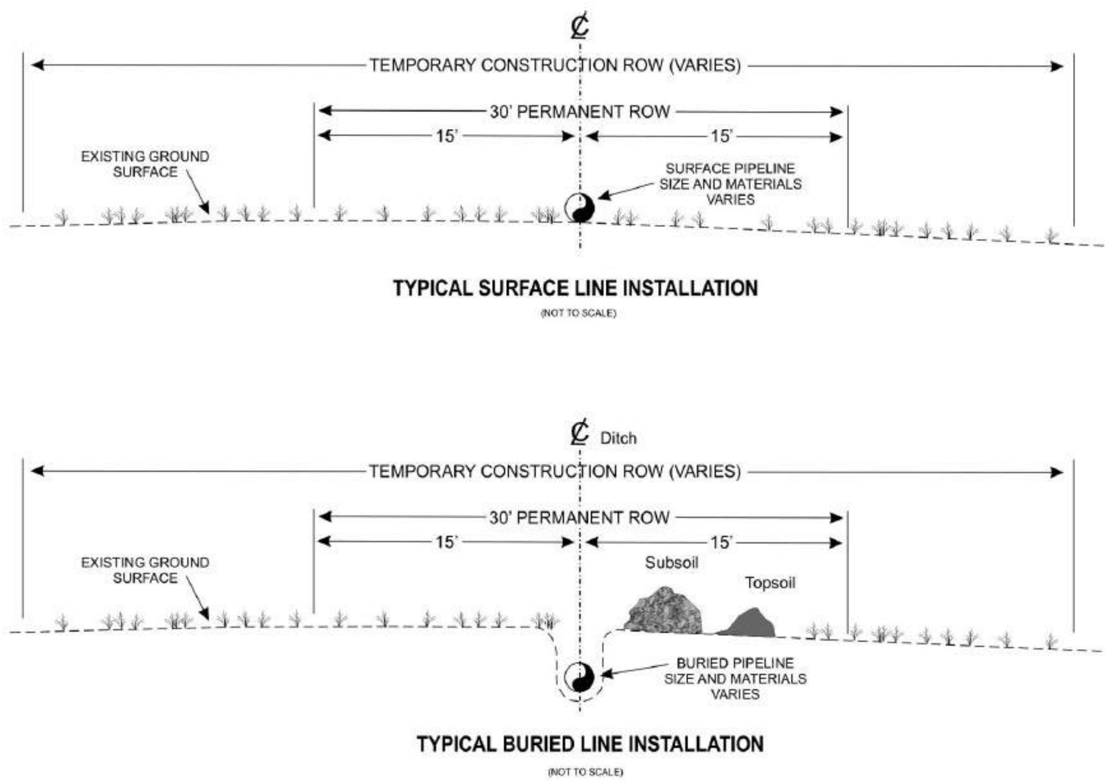


Figure 2.1.2.4-1. Typical "Cross-Country" Pipeline Installation Scenarios with Width Specifications

Figure 2.2.2.5-1. Typical Compressor Station Layout

Figure 2.2.2.5-1. Typical Compressor Station Layout

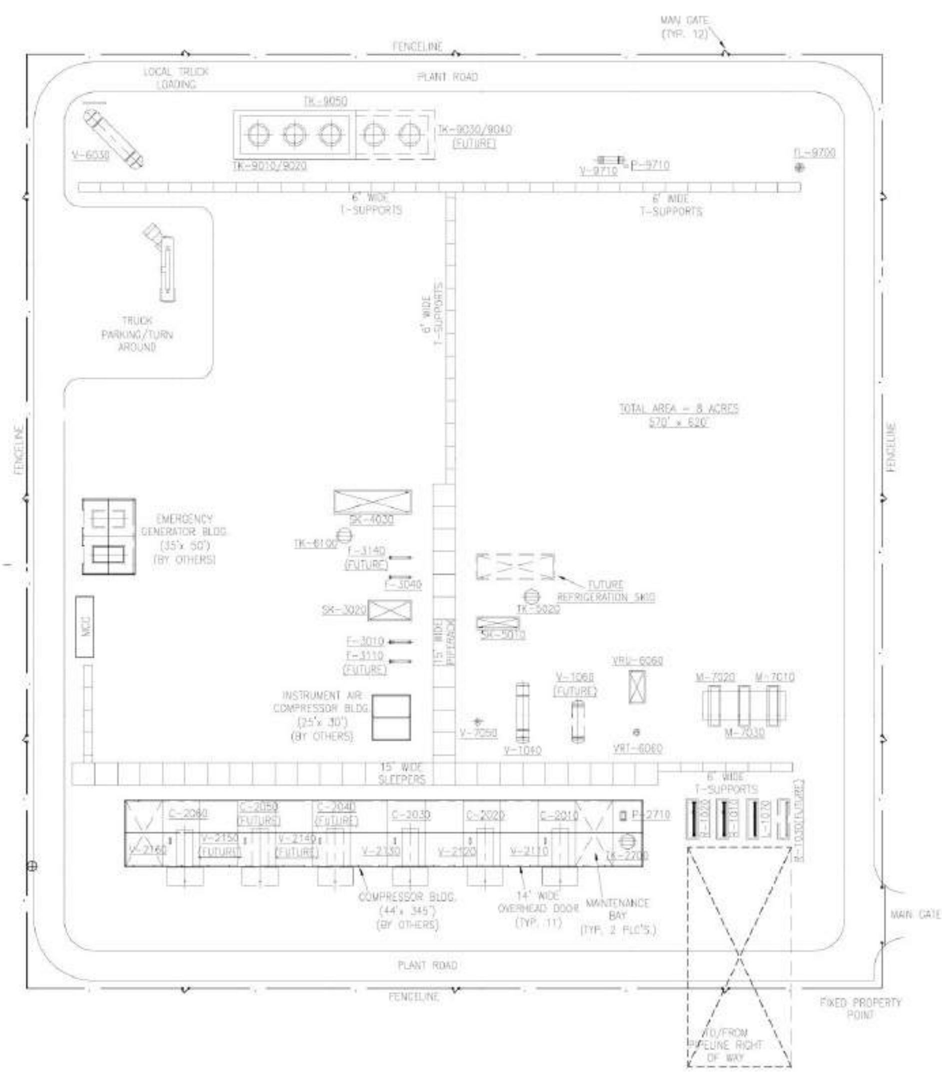


Figure 2.2.2.8-1. Typical Gas and Oil Separation Plant Layout

Figure 2.2.2.8-1. Typical Gas and Oil Separation Plant Layout

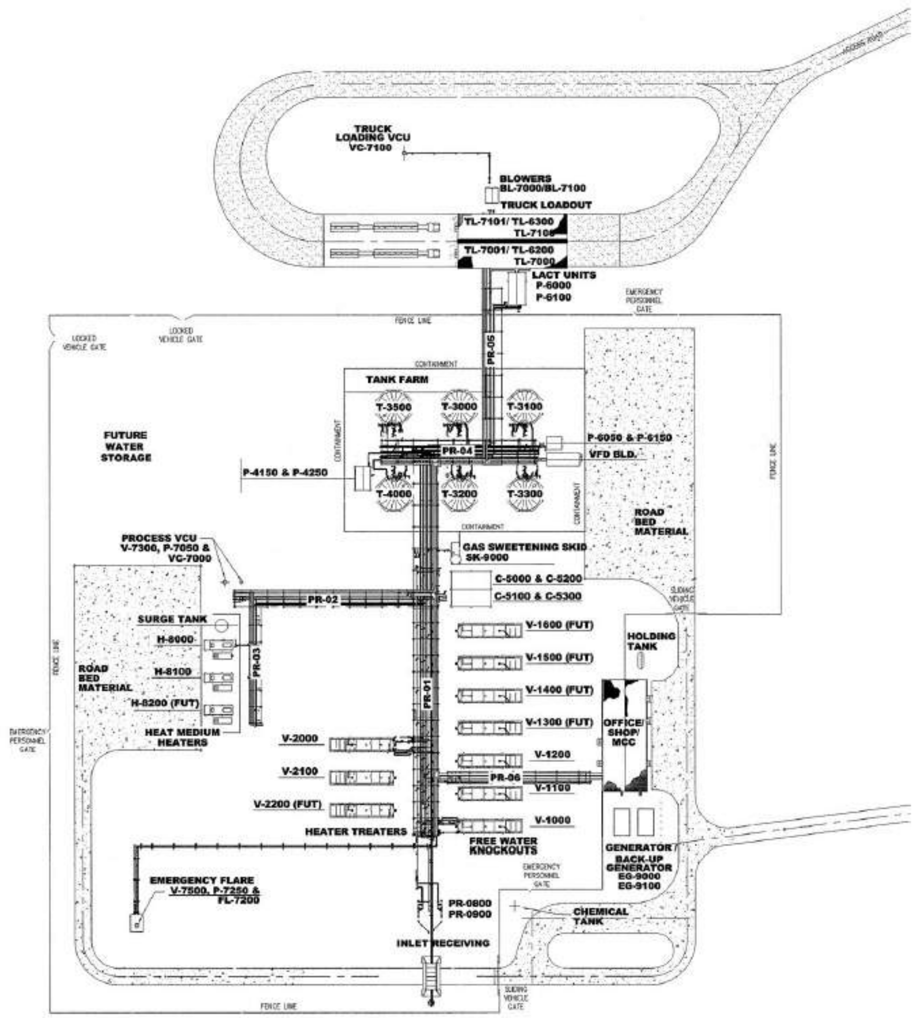
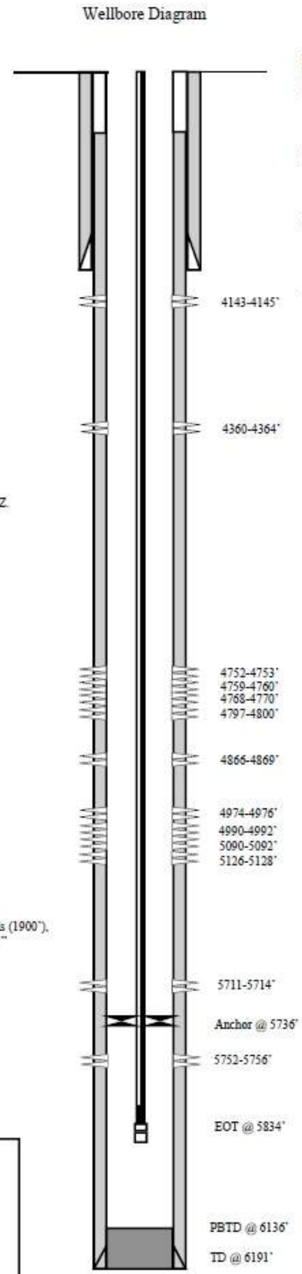


Figure 2.2.3-1 – Example Well Bore Diagram (GMBU C-2-9-17)

Figure 2.2.3-1 – Example Well Bore Diagram (GMBU C-2-9-17)

Spud Date: 7/15/2011
Put on Production: 9/7/2011
GL: 5006' KB: 5018'



SURFACE CASING

CSG SIZE: 8-5/8"
GRADE: J-55
WEIGHT: 24#
LENGTH: 16 jts. (716.42')
DEPTH LANDED: 728.74' KB
HOLE SIZE: 12-1/4"
CEMENT DATA: 350, sxs Class "G" cmt
TOC: Surface (7 bbls cmt circulated to pit 7/15/2011)

PRODUCTION CASING

CSG SIZE: 5-1/2"
GRADE: J-55
WEIGHT: 15.5#
LENGTH: 141 jts. (6165.04')
DEPTH LANDED: 6182.65' KB
HOLE SIZE: 7-7/8"
CEMENT DATA: 260 sxs Prem. Lite II mixed & 400 sxs 50/50 POZ.
TOC: 29 ft FS (CBL 8/22/2011)

TUBING

SIZE/GRADE/WT.: 2-7/8" / J-55 / 6.5#
NO. OF JOINTS: 184 jts. (5724.2')
TUBING ANCHOR: 5736.2' KB
NO. OF JOINTS: 1 jt. (31.4')
SEATING NIPPLE: 2-7/8" (1.1')
SN LANDED AT: 5770.4' KB
NO. OF JOINTS: 2 jts. (61.8')
NOTCHED COLLAR: 5833.3' KB
TOTAL STRING LENGTH: EOT @ 5834' KB

SUCKER RODS

POLISHED ROD: 1-1/2" x 30' Spray Metal Polished Rod
SUCKER RODS: 1 – 7/8" x 2' Pony Rod, 76 – 7/8" 4per Guided Rods (1900'), 145 – ¾" 4per Guided Rods (3625'), 5 – 1½" Sinker Bars (125'), 5 – 1" Stabilizer Bars (20')
PUMP SIZE: 2-1/2" x 1-3/4" x 20' x 21' x 24' RHAC
STROKE LENGTH:
PUMP SPEED: 5 SPM

FRAC JOB

8/22/2011	5711-5756'	**Frac CP1 and CP2, sands as follows:** Frac with 39387# 20/40 white sand in 260 bbls Lightning 17 fluid; 434 bbls total fluid to recover.
8/31/2011	4974-5128'	**Frac C, B1 and B2, sands as follows:** Frac with 46023# 20/40 white sand in 300 bbls Lightning 17 fluid; 428 bbls total fluid to recover.
8/31/2011	4752-4869'	**Frac D1, D2 and DS3, sands as follows:** Frac with 199586# 20/40 white sand in 1222 bbls Lightning 17 fluid; 1348 bbls total fluid to recover.
8/31/2011	4143-4364'	**Frac GB2 and GB6, sands as follows:** Frac with 50997# 20/40 white sand in 311 bbls Lightning 17 fluid; 418 bbls total fluid to recover.

PERFORATION RECORD

5752-5756'	3 JSPF	12 holes
5711-5714'	3 JSPF	9 holes
5126-5128'	3 JSPF	6 holes
5090-5092'	3 JSPF	6 holes
4990-4992'	3 JSPF	6 holes
4974-4976'	3 JSPF	6 holes
4866-4869'	3 JSPF	9 holes
4797-4800'	3 JSPF	9 holes
4768-4770'	3 JSPF	6 holes
4759-4760'	3 JSPF	3 holes
4752-4753'	3 JSPF	3 holes
4360-4364'	3 JSPF	12 holes
4143-4145'	3 JSPF	6 holes

NEWFIELD

Greater Monument Butte C-2-9-17
502' FNL & 1961' FEL (NW/NE)
Section 2, T9S, R17E
Uintah County, Utah
API #43-047-51551; Lease #ML-45555

TW 11/29/2011
Updated by JKP 12/1/2011

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Figure 2.2.8.3-1 Example Water Collector Well

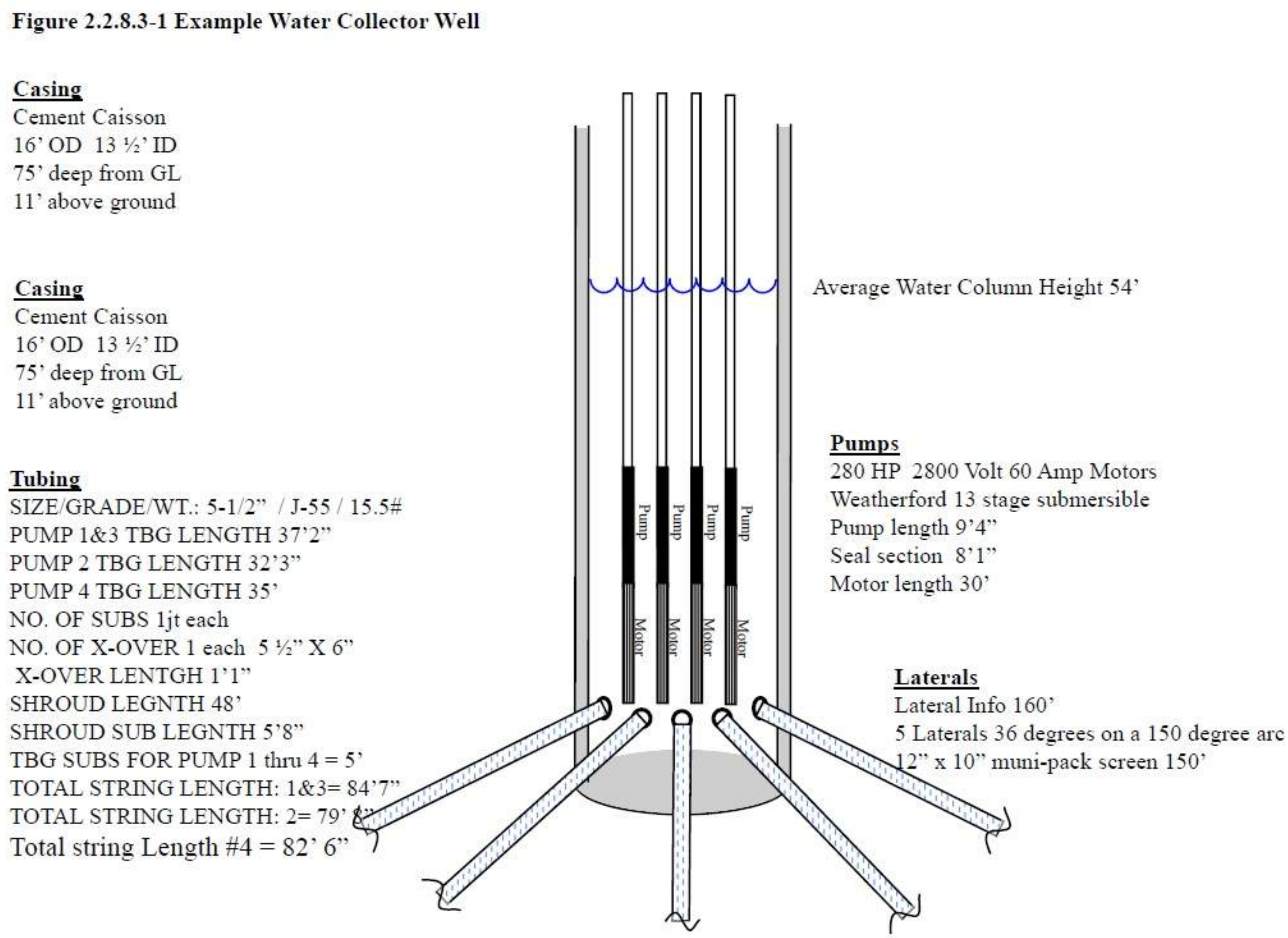

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Figure 2.3-1 Active, Inactive, and Future Wells Within the MBPA

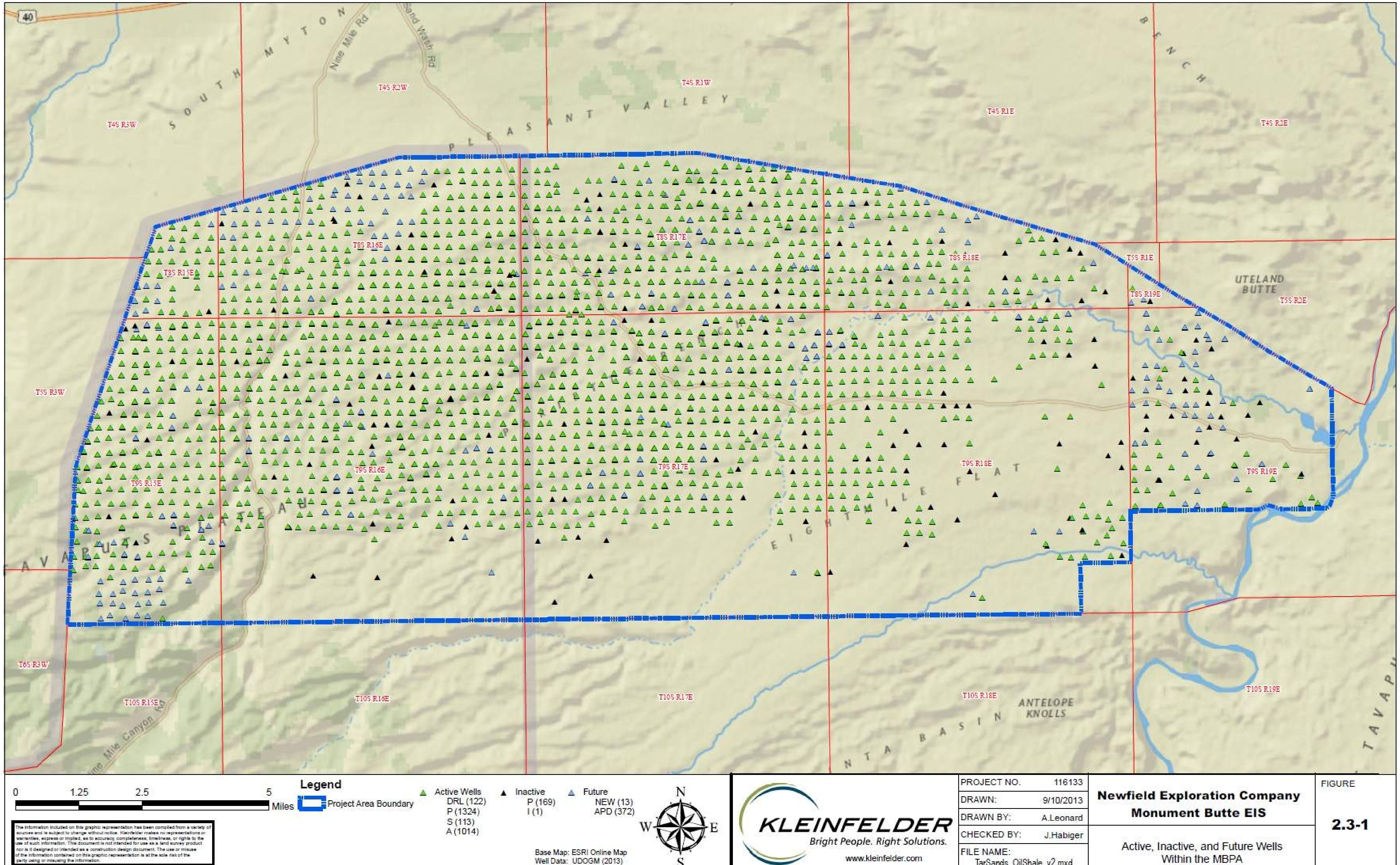

Figure 2.4 Newfield Production Company Alternative D – Agency Preferred Alternative

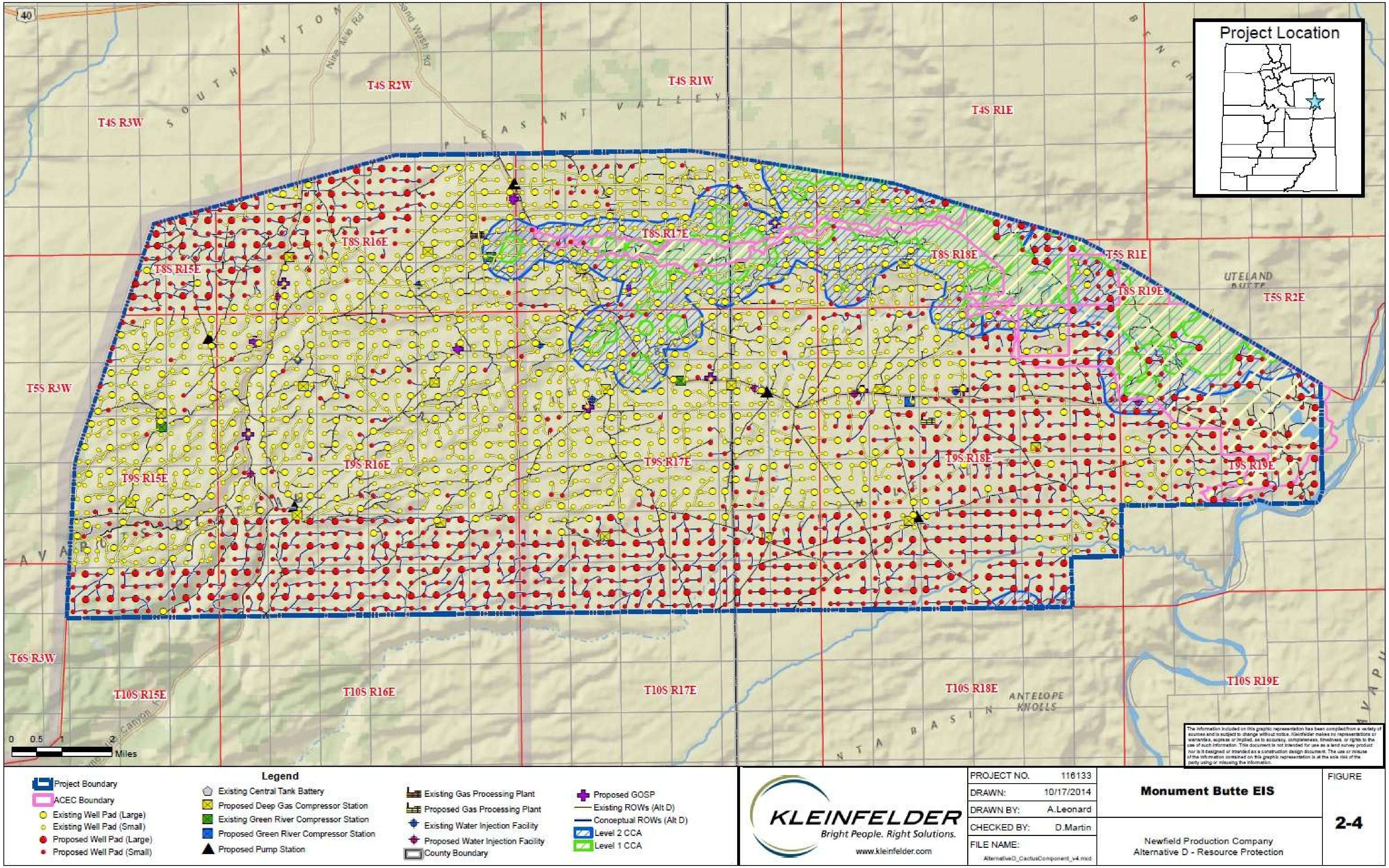

Figure 2.6-1 High- and Low-Density Development Areas Under Alternative D

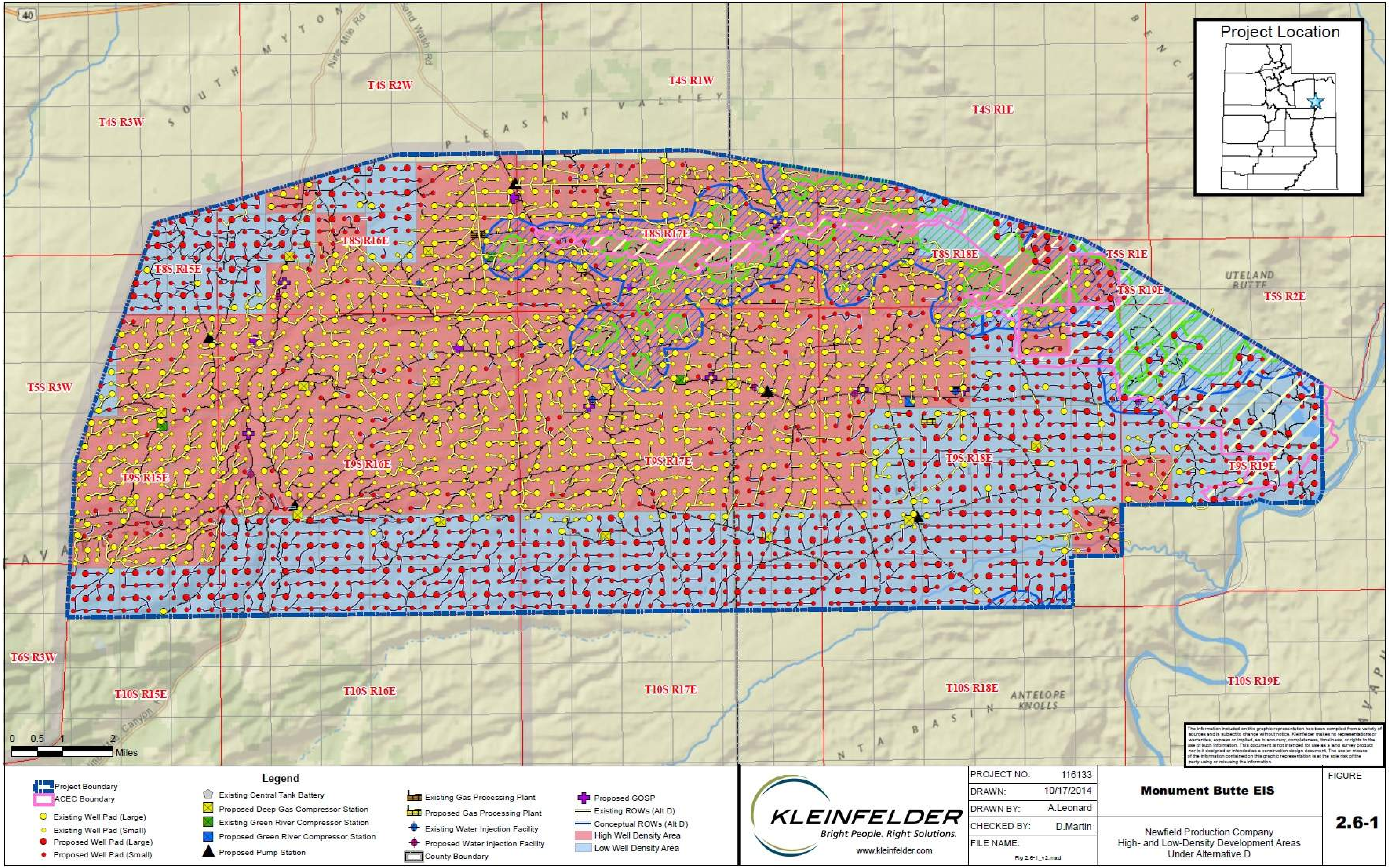

Figure 2.6-2 Newfield Production Company Low-Density Development Scenario for Alternative D

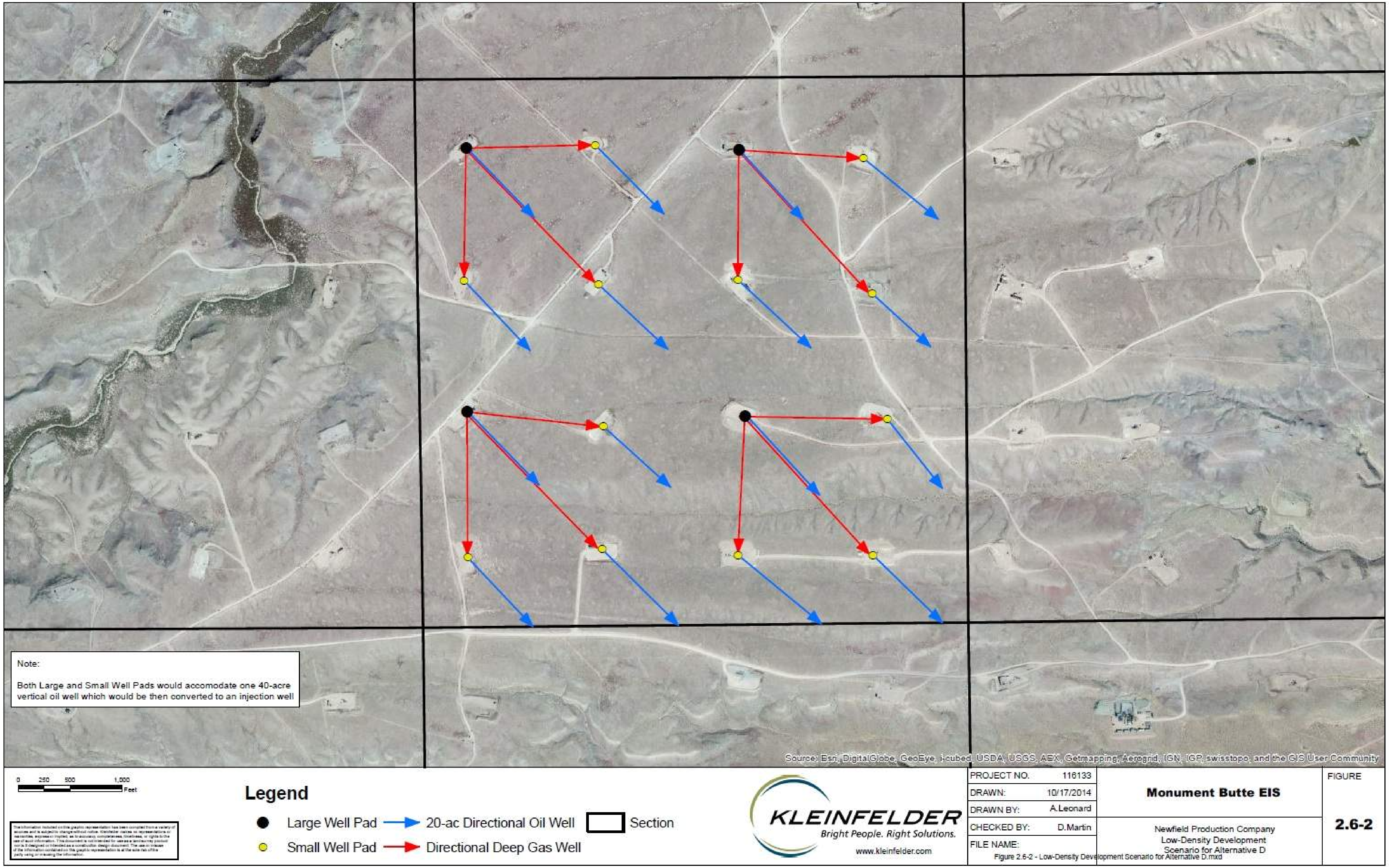

Figure 2.6-2B Comparison of a Typical 640-acre Section Drilled at a 40-acre Spacing (16 Well Pads) (A), with Simulations of Four of the Well Pads Expanded for Directional Drilling, and the Conversion of the Remaining 12 Well Pads into Water-flood Injection Wells as Shown in Yellow (B)

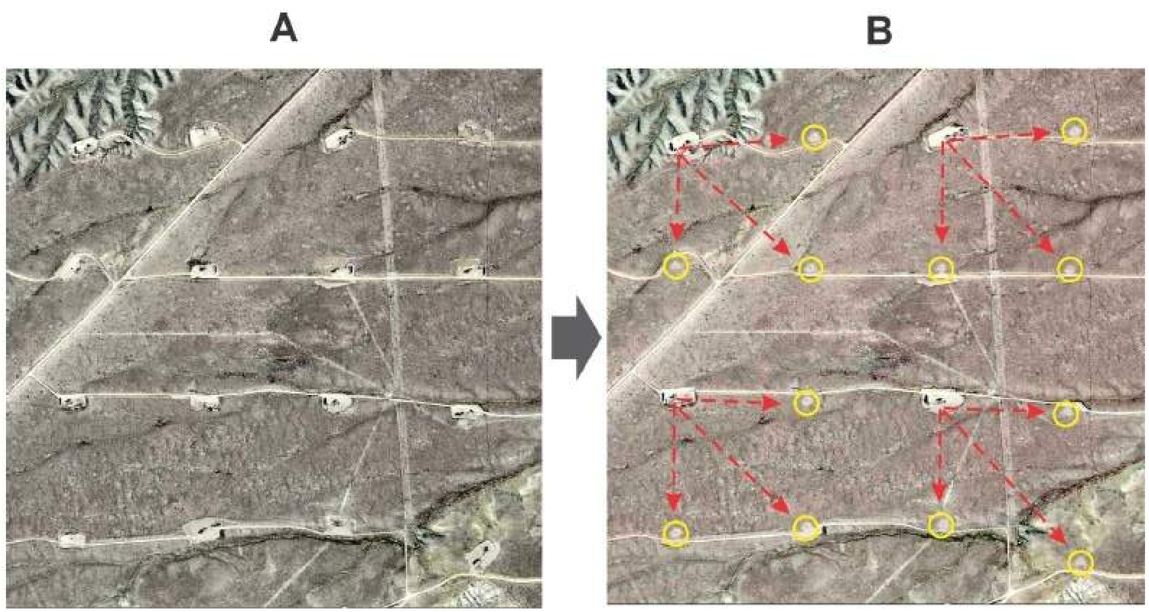

Figure 2.6-2. Comparison of a Typical 640-acre Section Drilled at a 40-acre Surface Spacing (16 Well Pads) (A), with Simulations of Four of the Well Pads Expanded for Directional Drilling, and the Conversion of the Remaining 12 Well Pads Into Water-flood Injection Wells as Shown in Yellow (B).

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Figure 3.6.3.2-1 Surface Water and Floodplains Uintah & Duchesne Counties, Utah

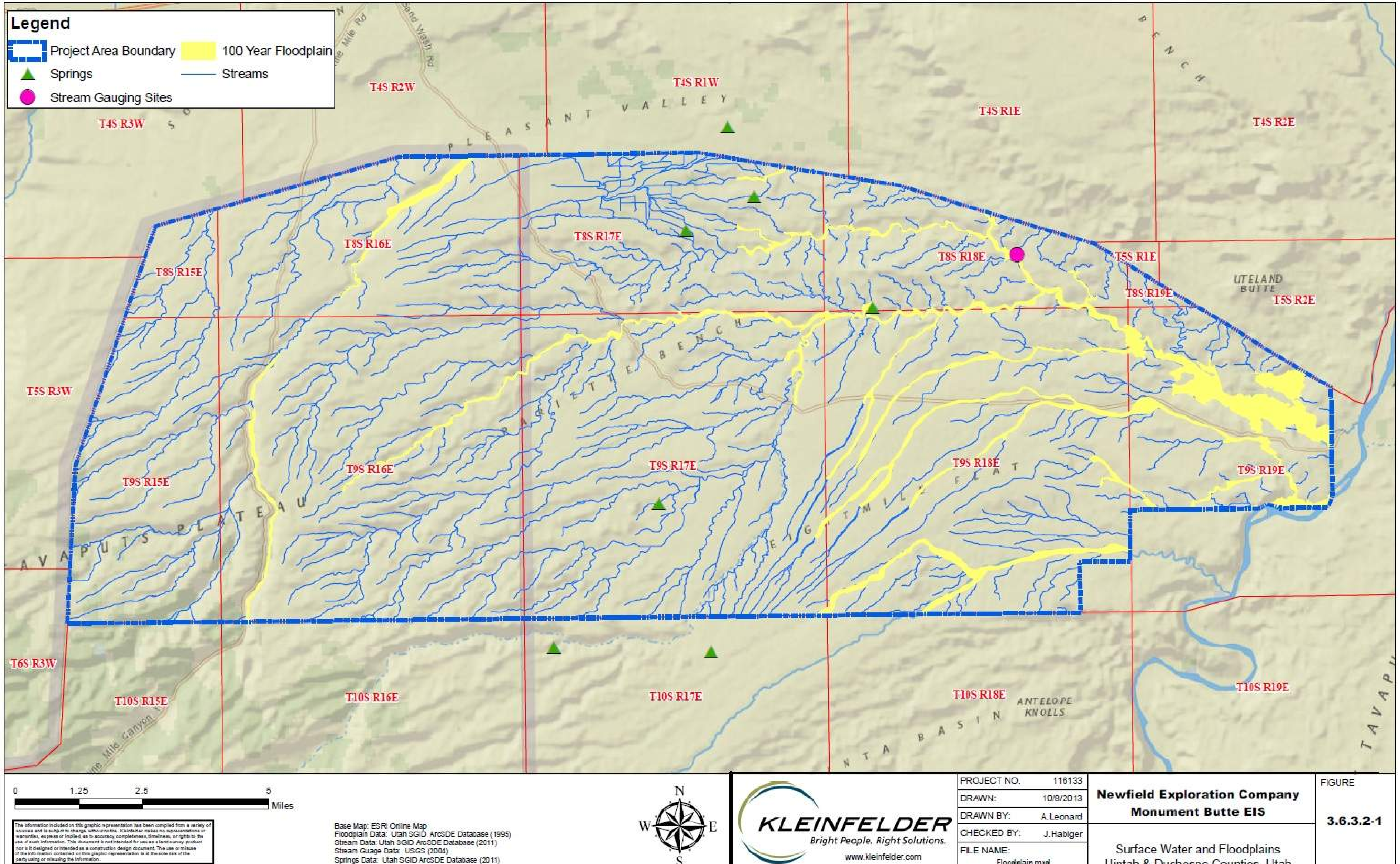

Figure 3.10.1.2-1 Potential Cactus Habitat and Core Conservation Areas Within the MBPA

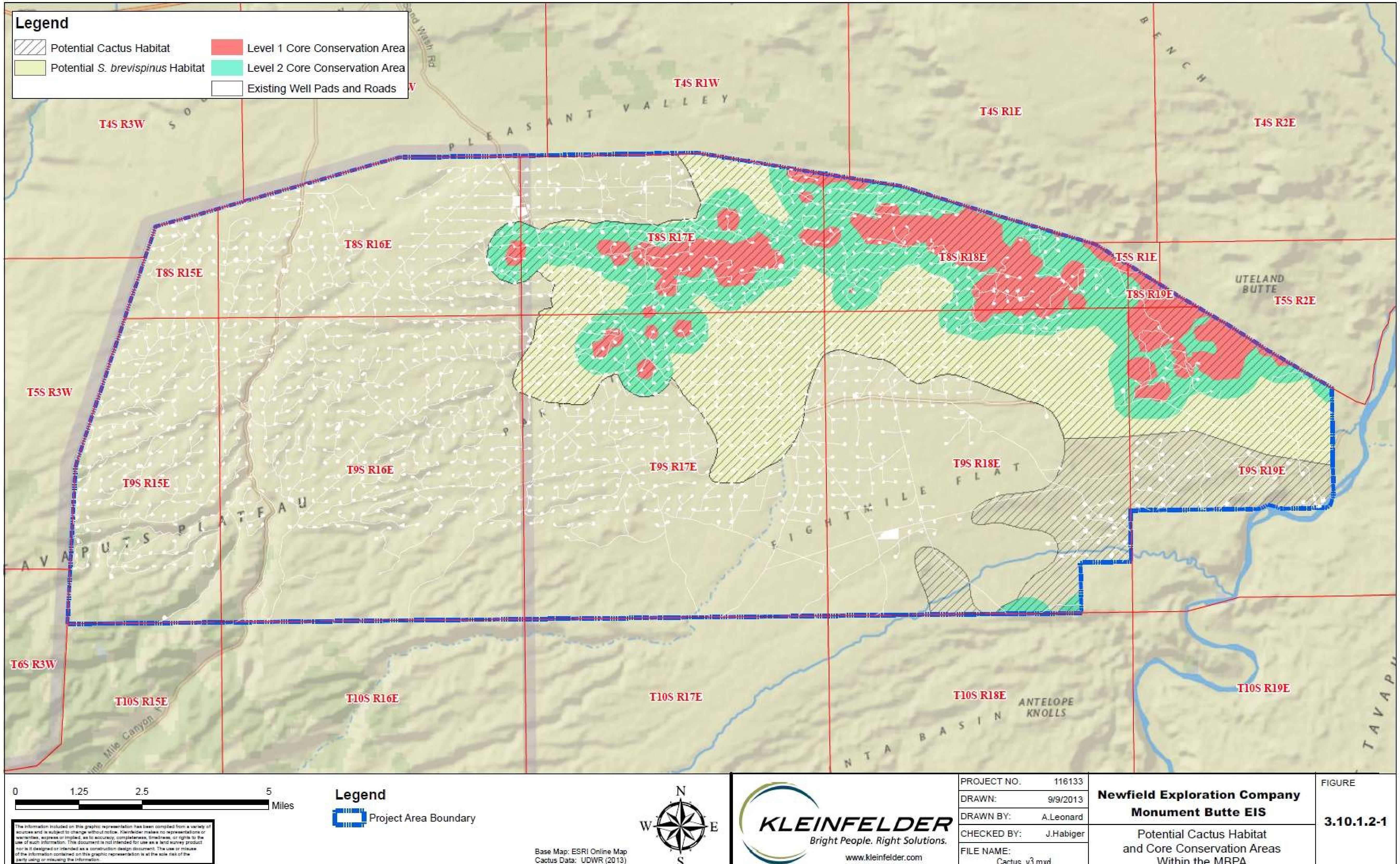
Legend
Potential Cactus Habitat
Potential S. brevispinus Habitat
Level 1 Core Conservation Area
Level 2 Core Conservation Area
Existing Well Pads and Roads
T4S R3W
T4S R1W
T4S R1E
T4S R2E
PLEASANT VALLEY
BENCH
T8S R15E
T8S R16E
T8S R17E
T8S R18E
T5S R1E
T8S R19E
UTELAND BUTTE
T5S R2E
T5S R3W
T9S R15E
T9S R16E
T9S R17E
T9S R18E
T9S R19E
EIGHTMILE FLAT
AVAPUTS PLATEAU
T6S R3W
T10S R15E
T10S R16E
T10S R17E
T10S R18E
T10S R19E
ANTELOPE KNOLLS
0 1.25 2.5 5 Miles
Legend
Project Area Boundary
Base Map: ESRI Online Map
Cactus Data: UDWR (2013)
N S W E
KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com
PROJECT NO. 116133
DRAWN: 9/9/2013
DRAWN BY: A.Leonard
CHECKED BY: J.Habiger
FILE NAME: Cactus_v3.mxd
Newfield Exploration Company
Monument Butte EIS
Potential Cactus Habitat and Core Conservation Areas Within the MBPA
FIGURE
3.10.1.2-1

Figure 5.1-1 Past, Current, and Reasonably Foreseeable Actions within and Near the MBPA

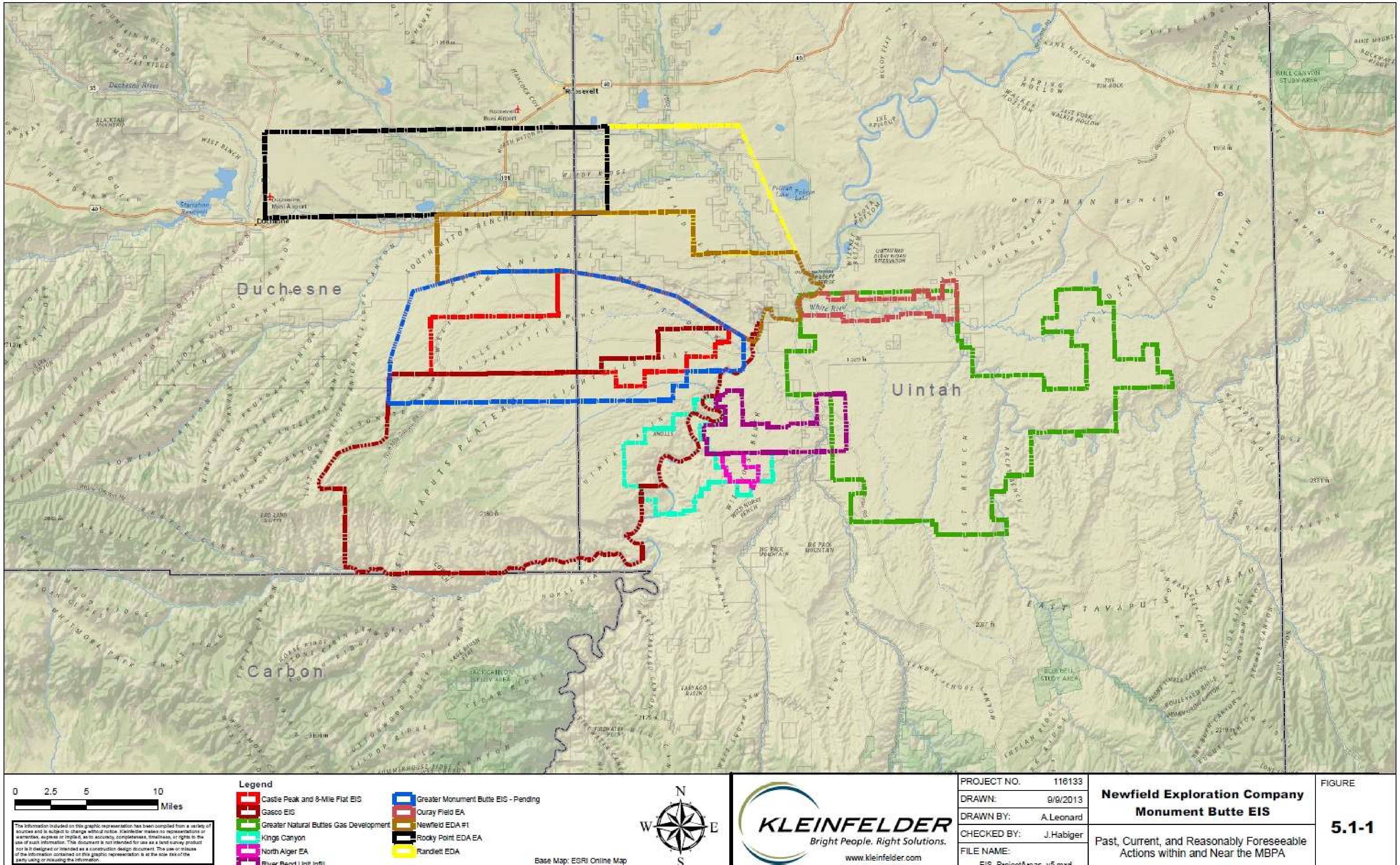

Figure 5.1-2 Cumulative Impact Analysis Areas

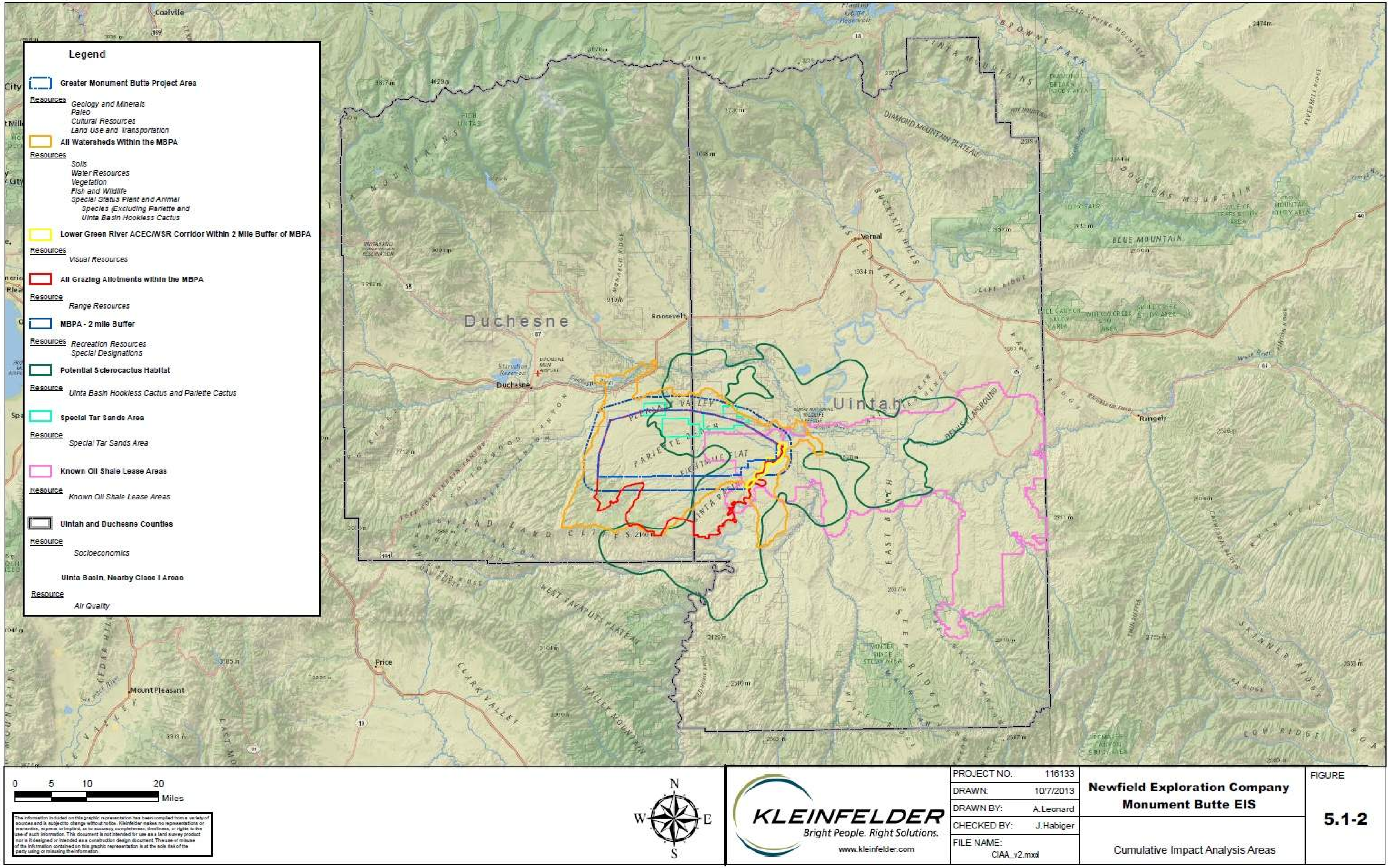

Figure 6 Undeveloped Leases in Core 1 Conservation Area

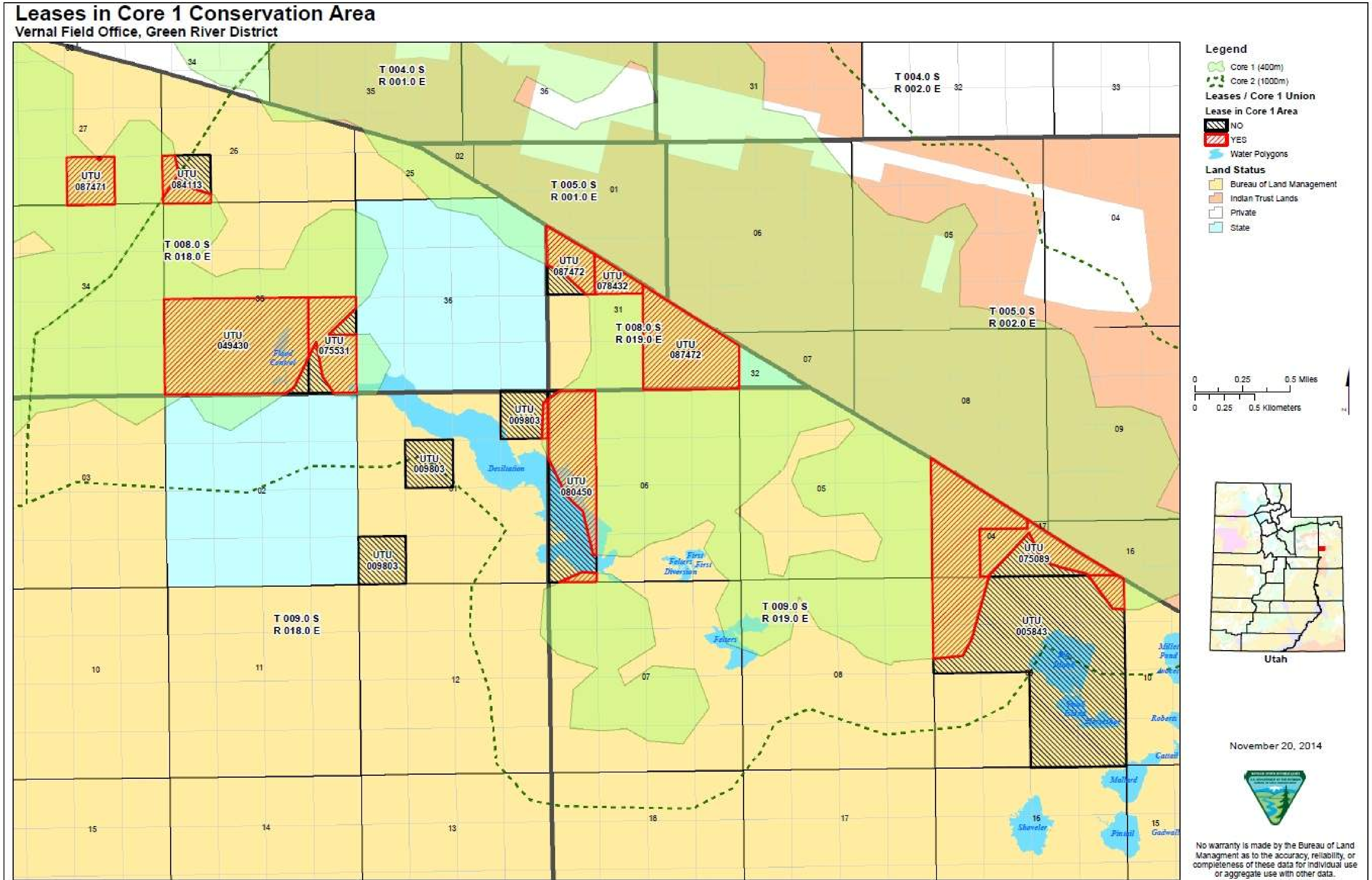
Leases in Core 1 Conservation Area
Vernal Field Office, Green River District
Legend
Core 1 (400m)
Core 2 (1000m)
Leases / Core 1 Union
Lease in Core 1 Area
NO
YES
Water Polygons
Land Status
Bureau of Land Management
Indian Trust Lands
Private
State
0 0.25 0.5 Miles
0 0.25 0.5 Kilometers
Utah
November 20, 2014
No warranty is made by the Bureau of Land Managment as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data.
T 004.0 S R 001.0 E
T 004.0 S R 002.0 E
T 005.0 S R 001.0 E
T 005.0 S R 002.0 E
T 008.0 S R 018.0 E
T 008.0 S R 019.0 E
T 009.0 S R 018.0 E
T 009.0 S R 019.0 E
UTU 087471
UTU 084113
UTU 049430
UTU 075531
UTU 087472
UTU 078432
UTU 009803
UTU 080450
UTU 075089
UTU 005843
Desilting
Pariette
Mallard
Pintail
Shoveler
Gadwall
Cattail
Roberts

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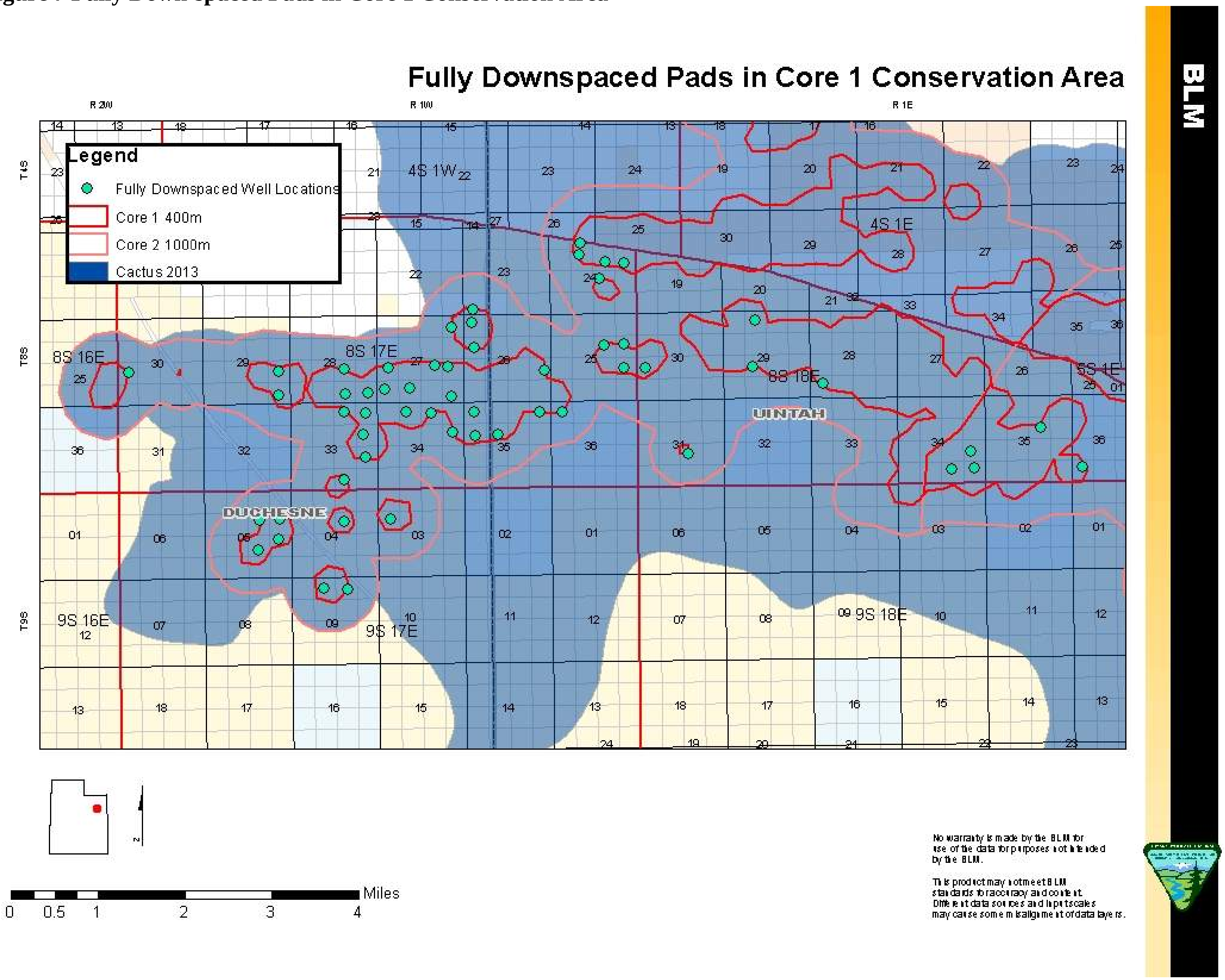
Figure 7 Fully Down-spaced Pads in Core 1 Conservation Area



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ATTACHMENT A Summary of Potential Occurrence of Special Status Plant Species

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Species	Status[1]	Habitat Association	Potential for Occurrence Within the Proposed Monument Butte Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Plants				
Ackerman's frasera *Frasera ackermaniae*	S	Clay semi-barrens on the Chinle Formation with scattered *Juniperus osteosperma*; 5,830 to 6,000 feet; flowers June.	None. Species is endemic to a 40 acre area in northern Uintah County	Yes. Species range is outside of Project Area.
Barneby's catseye *Cryptantha barnebyi*	S	White, semi-barren shale knolls of the Green River Formation; oil shale; gently sloping white shale barrens; shadscale-saltbush or pinyon-juniper communities; 6,000-7,900 feet.	Moderate. Formation and associated soils occur in the Project Area. However, little is known about the species' exact habitat requirements	No. Potential habitat occurs in the Project Area.
Barnaby's ridgecress *Lepidium barnebyanum*	E	Tribal lands in Duchesne County. Tavaputs Plateau; Uinta Formation; white shale ridgecrests; pinyon-juniper community; 6,200-6,500 feet; flowers May - June.	None. No potential habitat. Known populations occur outside of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Clay reed-mustard *Schoenocrambe argillacea*	T	Grows in steep, nearly inaccessible sites such as are unlikely to have been altered much by recent human activity, sc.: narrow ledges and overhangs of steep, north-facing slopes, often in somewhat protected nooks, crevices and cavities. Preferred soils are usually clayey sand derived from shales and sandstones in the contact zone of the Uinta and Green River Formations. It has also been reported growing on soils rich in gypsum, and on the Evacuation Creek Member of the Green River Formation.	None. No potential habitat. Known populations occur south and outside of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Gibben's penstemon *Penstemon gibbensii*	S	Shaly slopes and bluffs along the Green River, with mixed desert shrubs and scattered juniper; 5,500 to 7,700 feet; flowers June.	None. Species is endemic to Daggett County and does not occur near Project Area.	Yes. Project Area does not occur in species range.
Goodrich's blazingstar *Mentzelia goodrichii*	S	Steep, white, calciferous shale cliffs of the Green River Formation; escarpments of Willow & Argyle Canyons; open mountain brush communities; 8,100-8,800 feet.; flowers July - August.	Moderate. Formation and associated soils occur in the Project Area. However, little is known about the species' exact habitat requirements	Yes. Project Area does not occur in elevation range.
Goodrich's columbine *Aquilegia scopulorum var. goodrichii*	S	Green River shale ridges; bristlecone pine, limber pine, Salina wildrye, mountain mahogany, pinyon, and Douglas-fir communities; 7,400 to 9,400 feet	Moderate. Formation and associated soils occur in the Project Area. However, little is known about the species' exact habitat requirements	Yes. Project Area does not occur in elevation range.

Species	Status[1]	Habitat Association	Potential for Occurrence Within the Proposed Monument Butte Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Goodrich's penstemon *Penstemon goodrichii*	S	Duchesne and Uintah County, near Lapoint, Tridell, Whiterocks; Duchesne River Formation; clay badlands; desert shrub, shadscale, pinyon-juniper or mountain brush communities; 5,590-6,215 feet.; flowers late May - June.	None. No potential habitat. Known populations occur in northern Uintah County; outside of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Goodrich cleomella *Cleomella palmeriana* var. *goodrichi*	S	Morrison Formation, heavy clay; mat-salt-bush, Cicsco woody aster, salt desert shrub community; 4,000-6,000 feet; flowers May.	None. No potential habitat. The geological formation and soils associated with this species do not occur in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Graham's catseye *Cryptantha grahamii*	S	Green River Formation shale in mixed desert shrub, sagebrush, pinyon-juniper, and mountain brush communities; 5,000-7,400 feet.	Moderate. Formation and associated soils occur in the Project Area. However, little is known about the species' exact habitat requirements	No. Potential habitat occurs in the Project Area
Graham's beardtongue (Graham's penstemon) *Penstemon grahamii*	P	Grows directly on the weathered exposures of oilshale strata associated with the Parachute Creek Member and Evacuation Creek Member of the Green River Formation. Oil shale or white shale knolls & talus; semi-barren mixed desert shrub or pinyon juniper communities; 4,600-6,700 feet; flowers from late May - mid-June.	Low. The geological formation and soils associated with this species does not occur. Known populations are located south and east of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Green River greenthread *Thelesperma caespitosum*	S	White shale benches and windswept slopes of the Green River and Uinta Formation with pinyonjuniper and mountain mahogany communities;. 5,900–8,400 feet.	Moderate. Formation and associated soils occur in the Project Area. However, little is known about the species' exact habitat requirements.	No. Potential habitat occurs in the Project Area.
Hamilton milkvetch *Astragalus hamiltonii*	S	Duchesne River, Mowry, Dakota & Wasatch Formations; mixed desert shrub or pinyon-juniper communities; 5,240-5,800 feet; flowers May-June.	None. No populations, potential or suitable habitat occurs for this species in this area. Known populations occur near Vernal; outside of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Horseshoe milkvetch *Astragalus equisolensis*	S	East of Green River, Horseshoe Bend; Duchesne River Formation soils; mixed desert shrub communities; 4,790-5,185 feet.; flowers May-early June	None. No populations, potential or suitable habitat occurs for this species in this area. Known populations occur along the upper Green River; outside of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Huber's pepperplant *Lepidium huberi*	S	Uinta Mountain foothills, Book Cliffs; Chinle, Park City, Weber Formation; eroding cliffs, alluvium; black sage or mountain brush communities; 5,000- 9,700 feet.; flowers June-August	None. No potential habitat. The geological formation and soils associated with this species do not occur in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.

Species	Status[1]	Habitat Association	Potential for Occurrence Within the Proposed Monument Butte Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Park rock cress *Arabis vivariensis*	S	Weber Formation sandstone & limestone outcrops; mixed desert shrub or pinyon-juniper communities; 5,000-6,000 feet; flowers May.	None. The geological formation and soils associated with this species do not occur in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Pariette cactus *Sclerocactus brevispinus*	T	Pariette Bench south of Myton, grows in flat soil surfaces to slightly rolling hills. Preferred soils are the fine alkaline clays overlain by a pavement of hard, flat, angular, desert-varnished sandstone fragments derived from the Wagonhound Member of the Uinta Formation; shadscale, mat-saltbush community; 4,700-5,400 feet.	High. The Project Area is located within the USFWS *Sclerocactus* polygon.	No. Suitable habitat is present in the Project Area.
Rock bitterweed *Hymenoxys lapidicola*	S	Blue Mountain; Weber Formation, sandy ledges & crevices; pinyon-juniper or ponderosa-manzanita communities; 5,700-8,100 feet; flowers June.	None. The geological formation and soils associated with this species do not occur in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Shrubby reed-mustard *Schoencrambe suffrutescens*	E	Duchesne, Uintah: Green River Formation; Badlands Cliffs, Gray Knolls, Big Pack Mountain; calcareous shale; mixed desert shrub, pinyon-juniper or mountain brush communities; 5,400-6,000 feet; flowers late May - mid-August.	None. The geological formation and soils associated with this species do not occur. Known populations occur south and southeast of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Sterile Yucca *Yucca sterilis*	S	Salt and mixed desert shrub communities growing in sandy soils, 4,800-5,800 feet.	Moderate. Formation and associated soils occur in the Project Area.	No. Potential habitat occurs in the Project Area.
Stemless penstemon *Penstemon acaulis var. acaulis*	S	Pinyon-juniper and sagebrush-grass communities on semi-barren substrates; 5,900-8,200 feet; flowers June-July.	None. Species is endemic to Daggett County and does not occur near Project Area.	Yes. Project Area does not occur in species range.

Uinta Basin hookless cactus *Sclerocactus wetlandicus*	T	Found within clay bad-lands all the way up into pinyon-juniper habitats. At the species core its preferred habitat seems to be Pleistocene outwash terraces with xeric, coarse-textured, alkaline soils overlain by a surficial pavement of large, smooth, rounded cobble. It occurs most commonly on south-facing exposures, where terrace deposits break from level slopes to steeper side slopes at approximately 30% grade, between 4,500-5,900 feet.	High. The Project Area is located within the USFWS *Sclerocactus* polygon.	No. Suitable habitat is present in the Project Area.
Species	**Status[1]**	**Habitat Association**	**Potential for Occurrence Within the Proposed Monument Butte Project Area and Cumulative Effects Area**	**Eliminated From Detailed Analysis? (Yes/No)**
Untermann daisy *Erigeron untermannii*	S	West Tavaputs Plateau; Green River, Uinta Formation; ridges; dry calcereaous shales and sandstones; pinyon-juniper or mountain brush communities; 7,000-9,400 feet. Flowers May–June.	Moderate. There are known populations in the vicinity of the Project Area within the Indian Canyon.	Yes. Project Area does not occur in elevation range.
Ute ladies'-tresses *Spiranthes diluvialis*	T	Green River tributaries, Uinta Mountains, Browns Park, Book Cliffs; unconsolidated alluvium; wetland meadow communities; 4,400-6,810 feet.; flowers late July - September	Low. No known populations exist in the Project Area, but potential habitat may occur in association with riparian areas.	No. Potential habitat may be present along riparian areas.
White River beardtongue *Penstemon scariosus* var. *albifluvis*	P	Grows on raw shale barrens and oil shale barrens of the Evacuation Creek and Para-chute Creek Member of the Green River Formation. Soils are xeric, calcareous, fine-textured, whitish or reddish clays overlain by a white shale chips; 5,000-6,800.	None. Known populations occur in the upper White River; east of the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.

[1] Status: E = Federally listed as endangered; T = Federally listed as threatened; P = Federal proposed species; S = BLM sensitive species, Vernal Field Office

Source: Adapted from BLM Vernal Field Office, Special Status Plant Species List (UDWR 2011b).
Source for location information: USFWS 2012, UNPS 2007, and Goodrich and Neese 1986.

ATTACHMENT B Summary of Potential Occurrence of Special Status Fish and Wildlife

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Species	Status[1]	Habitat Association	Potential for Occurrence Within the Proposed Monument Butte Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Birds				
American white pelican *Pelecanus erythrorhynchos*	S SPC	Inhabits areas of open water including large rivers, lakes, ponds, and reservoirs with surrounding habitats ranging from barren to heavily vegetated sites. Typically nests on isolated islands in lakes or reservoirs.	Low. In Utah, the species is known to nest on islands associated with Great Salt and Utah lakes.	**No. Potential habitat for this species occurs along the eastern edge of the Project Area.**
Bald eagle *Haliaeetus leucocephalus*	BGEPA SPC	In Utah, breeding occurrences are limited to eight locations within four counties (Daggett, Davis, Grand, Duchesne, Emery, Grand, and Wayne counties). Winter habitat typically includes areas of open water, adequate food sources, and sufficient diurnal perches and night roosts.	Moderate. Bald eagle winter roosting habitat occurs along the eastern edge of the Project Area in the Green River riparian corridor.	**No. Winter roosts sites are located along the eastern edge of the Project Area.**
Black swift *Cypseloides niger*	S SPC	This species requires waterfalls for nesting; typically the falls are permanent. Coniferous forests, often mixed conifer or spruce-fir forests, typically surround nesting sites, but this varies depending on elevation and aspect, and nest sites may include mountain shrub, aspen, or even alpine components. Streams that create the waterfalls are typically mountain riparian habitats.	None. Suitable habitat for this species does not exist in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Bobolink *Dolichonyx oryzivorus*	S SPC	Inhabits mesic and irrigated meadows, riparian woodlands, and subalpine marshes at lower elevations (2,800–5,500 feet). Suitable breeding habitat includes tall grass, flooded meadows, prairies, and agricultural fields; forbs and perch sites also are required.	Low. The species breeds in isolated areas of Utah, primarily in the northern half of the state. No breeding by this species has been documented in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Burrowing owl *Athene cunicularia*	S SPC	Inhabits desert, semi-desert shrubland, grasslands, and agricultural areas. Nesting habitat primarily consists of flat, dry, and relatively open terrain; short vegetation; and abandoned mammal burrows for nesting and shelter. Breeding season: April through July 15.	Moderate to High. Scattered prairie dog colonies are located in the Project Area which this species may utilize for nesting.	**No. Burrowing owls, nesting sites, and suitable habitat in the Project Area.**

Species	Status[1]	Habitat Association	Potential for Occurrence Within the Proposed Monument Butte Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Ferruginous hawk *Buteo regalis*	S SPC	In Utah, this species resides mainly in lowland open desert terrain characterized by barren cliffs and bluffs, pinyon-juniper woodlands, sagebrush-rabbit brush, and cold desert shrub. Nesting habitat includes promontory points and rocky outcrops.	Moderate to High. Suitable foraging and nesting habitat for this species does occur in the Project Area.	**No. This species has been known to nest in the Project Area.**
Golden eagle *Aquilla chysaetos*	BGEPA	Found in mountainous areas, canyons, shrublands, and grasslands, and in shrub-steppe habitats in the winter. Populations in the northern parts of the breeding range migrate south for winter; however, most populations in Utah are year- round residents of the same area. In Utah, this species occurs in nearly all habitats from desert grasslands to mountainous regions. They occur in grass-scrub, shrub-sapling, and young woodland habitats with open lands for nearby hunting. Nests are constructed on cliffs or in large trees. Breeding season generally occurs from February 15 through May 30.	High. Nesting and foraging habitat is found throughout the Project Area.	**No. This species has been known to nest in the Project Area.**
Grasshopper sparrow *Ammodramus savannarum*	S SPC	Prefers grasslands of intermediate height and are often associated with clumped vegetation interspersed with patches of bare ground. Other habitat requirements include moderately- deep litter and sparse coverage of woody vegetation.	Low to Moderate. Breeding populations have been documented in the north portions of the state, including portions of Duchesne and Uintah Counties.	**No. Potential habitat for this species is present in the Project Area.**
Greater sage-grouse *Centrocercus urophasianus*	C	Inhabits upland sagebrush habitat in rolling hills and benches. Breeding occurs on open leks (or strutting grounds) and nesting and brooding occurs in upland areas and meadows in proximity to water and generally within a 1-mile radius of the lek. During winter, sagebrush habitats at submontane elevations commonly are used. Breeding season: March 1 through June 30.	Moderate. The species is widespread, but declining, in Utah, with extant populations in Uintah and Duchesne counties. Habitats have been identified in the Project Area.	**No. Habitats have been identified in the Project Area.**
Lewis's woodpecker *Melanerpes lewis*	S SPC	Inhabits open habitats including pine forests, riparian areas, and piñon-juniper woodlands. Breeding habitat typically includes ponderosa pines and cottonwoods in stream bottoms and farm areas. In Utah, the species inhabits agricultural lands and urban parks, montane and desert riparian woodlands, and submontane shrub habitats. Breeding season: mid-May through mid-August.	Low to Moderate. In Utah, the species is widespread, but is an uncommon nester along the Green River. Breeding by this species has been observed in Ouray in Uintah county, and along Pariette Wash.	**No. Potential habitat for this species may occur in the Project Area.**

Species	Status[1]	Habitat Association	Potential for Occurrence Within the Proposed Monument Butte Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Long-billed curlew *Numenius americanus*	S SPC	Inhabits shortgrass prairies, alpine meadows, riparian woodlands, and reservoir habitats. Breeding habitat includes upland areas of shortgrass prairie or grassy meadows with bare ground components, usually near water.	Low. Widespread migrant in Utah. Breeding birds are fairly common but localized, primarily in central and northwestern Utah. Potential nesting has been reported in Uintah County, but has not been confirmed.	**No. Potential habitat for this species may occur in the Project Area.**
Mountain plover *Charadrius montanus*	S SPC	This species is typically associated with shortgrass prairie habitat composed primarily of blue grama and buffalo grass (*Buchloe dactyloides*). However, habitat characteristics in the Uinta Basin are notably different from shortgrass prairie breeding areas. In Utah, this species has been recorded as a casual migrant in Box Elder, Weber, Salt Lake, and Daggett counties. Six (6) documented historical sightings have occurred in the Uinta Basin. One known breeding population that occured in Utah was located on Myton Bench. The Utah population bred in shrub- steppe habitat among white-tailed prairie dogs and near roadways or oil well pads.	Low to Moderate. The breeding population on Myton Bench has declined greatly in recent years. There have been no breeding bird sightings in Utah since 2005.	**No. Potential habitat for this species occurs in the Project Area.**
Northern goshawk *Accipiter gentilis*	S CS	Mature mountain forest and riparian zone habitats. The northern goshawk is a neotropical migrant that occurs across the northern regions of North America in scattered populations primarily in mature mountain forest and valley cottonwood habitats.	None. There is no suitable habitat for this species in the Project Area. Populations of northern goshawk have been identified in the mid elevations in the Uinta Mountains and the Book Cliffs.	Yes. Potential habitat for this species does not occur in the Project Area.
Mexican spotted owl *Strix occidentalis lucida*	T	This species is found primarily in canyons with mixed conifer forests, pine-oak woodlands and riparian areas. This species nests on platforms and large cavities in trees, on ledges, and in caves. Breeding and nesting season: approximately March through August.	None. No Mexican spotted owl suitable habitat or nests have been identified in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.

Species	Status[1]	Habitat Association	Potential for Occurrence Within the Proposed Monument Butte Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Short-eared owl *Asio flammeus*	S SPC	Inhabits arid grasslands, agricultural areas, marshes, and occasionally open woodlands. In Utah, cold desert shrub and sagebrush-rabbit brush habitats also are utilized. Typically a ground nester: April 10 through June 15.	Moderate. The species breeds in northern Utah and occurs as a migrant potentially throughout the state. Known to occur in Uintah County, with occurrence probable in Duchesne County.	**No. Potential habitat for this species occurs in the Project Area.**
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	C	This species is considered to be a riparian obligate and usually occurs in large tracts of cottonwood/willow habitats. However, this species also has been documented in lowland deciduous woodlands, alder thickets, deserted farmlands, and orchards. Breeding season: late June through July.	Low to Moderate Potential. Small patches of potential habitat occur immediately east of the Project Area and breeding has been confirmed at the Ouray National Wildlife Refuge.	**No. Suitable habitat occurs along the Green River east of the Project Area.**
Fish				
Bluehead sucker *Catostomus discobolus*	S CS	Occupies a wide range of aquatic habitats ranging from cold, clear mountain streams to warm, turbid rivers. This species occurs in the lower portion of Pariette Draw and in the Green River below the Pariette Draw confluence. Fast flowing streams have been identified as important habitat for this species.	Moderate. Suitable habitat for this species occurs along portions of the Green River east of the Project Area.	**No. Suitable habitat occurs for this species**
Bonytail *Gila elegans*	E	This species is endemic to the Colorado River system and currently is restricted to the Green River in Utah. They use main channels of large rivers and favor swift currents.	Moderate. Designated Critical Habitat for this species occurs at the segment of the Green River located approximately 20 miles downstream of the Project Area.	**No. Habitat for this species occurs downstream from the Project Area within the Green River.**

Species	Status[1]	Habitat Association	Potential for Occurrence Within the Proposed Monument Butte Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Colorado pikeminnow *Ptychocheilus lucius*	E	The range of the Colorado pikeminnow is restricted to the Upper Colorado River basin, upstream of Glen Canyon Dam. Adult Colorado pikeminnow use a variety of habitat types, depending on time of year, but mainly utilize shoreline runs, eddies, backwater habitats, seasonally flooded bottoms, and side canyons. They are most abundant in the upper Green River (between the mouth of the Yampa River and head of Desolation Canyon) and lower Green River (between the Price and San Rafael Rivers). Other concentration areas include the Yampa River, the lower 21 miles of the White River, and the Ruby and Horsethief Canyon area between Westwater, Utah, and Loma, Colorado.	Moderate to High. Critical habitat for this species is located along the Green River that flows through the eastern edge of the Project Area.	**No. Critical habitat is located along the Green River on the eastern edge of the Project Area.**
Flannelmouth sucker *Catostomus latipinnis*	S CS	Adults occur in riffles, runs, and pools in streams and large rivers, with the highest densities usually in pool habitat. Young live in slow to moderately swift waters near the shoreline areas.	Moderate to High. This species occurs in the Green River from the Colorado confluence up to the Flaming Gorge Reservoir.	**No. Habitat for this species occurs in the Green River along the eastern edge of the Project Area.**
Humpback chub *Gila cypha*	E	Suitable habitat for this species is characterized by a wide variety of riverine habitats, especially canyon areas with fast currents, deep pools, and boulder habitat. This species originally inhabited the main stem of the Colorado River from what is now Lake Mead to the canyon areas of the Green and Yampa River Basins. Currently, it appears restricted to the Colorado River at Black Rocks and Westwater Canyon of the Green River, and Yampa Canyon of the Yampa River. Suitable habitat and critical habitat has been designated for this species in the Green River in Uintah County.	Moderate. Designated Critical Habitat for this species occurs along the segment of Green River located approximately 20 miles downstream of the Project Area.	**No. Habitat for this species occurs downstream from the Project Area within the Green River.**

Species	Status[1]	Habitat Association	Potential for Occurrence Within the Proposed Monument Butte Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Razorback sucker *Xyrauchen texanus*	E	This fish species is found in a variety of habitats including quiet eddies, pools, and mid-channel runs. They are usually found over sand or silt substrate, but occur over gravel and cobble bars. The largest population is known to occur in the upper Green River between the confluence of the Yampa River and the confluence of the Duchesne River. Adults also occur in the Colorado River near Grand Junction, Colorado, although numbers are very low. Critical habitat has been designated for this species in the Green River in Carbon, Duchesne, Emery, Uintah and Grand Counties.	Moderate to High. Critical habitat for this species is located along the Green River that flows through the eastern edge of the Project Area.	**No. Critical habitat is located along the Green River on the eastern edge of the Project Area.**
Roundtail chub *Gila robusta*	S CS	This species is most often found in murky pools near strong currents in the main-stem Colorado River and its large tributaries. Adults inhabit low to high flow areas in the Green River; young occur in shallow areas with minimal flow.	Moderate. Known distribution of this species includes portions of the Green River along the eastern edge of the Project Area.	**No. Habitat for this species occurs in the Green River along the eastern edge of the Project Area.**
Mammals				
Big free-tailed bat *Nyctinomops macrotis*	S SPC	The species is rare in Utah, occurring primarily in the southern half of the state, although individuals may rarely occur in northern Utah. Prefers rocky and woodland habitats, where roosting occurs in caves, mines, old buildings, and rock crevices.	Low. High cliffs that bats may use for roosting do not occur in the Project Area. Some suitable roosting habitat is present along the Green River.	**No. Potential habitat for this species may occur in the Project Area.**
Black-footed ferret *Mustela nigripes*	E	This species inhabits semi-arid grasslands and mountain basins. It is found primarily in association with active prairie dog colonies that contain suitable burrow densities and colonies that are of sufficient size.	None. Suitable habitat is not present.	Yes. Potential habitat for this species does not occur in the Project Area.
Canada lynx *Lynx canadensis*	E	Primarily occurs in Douglas-fir, spruce-fir, and subalpine forests at elevations above 7,800 feet. The lynx uses large woody debris such as downed logs and windfalls to provide denning sites for protection and thermal cover for kittens.	None. If extant in Utah, this species most likely occurs in montane forests in the Uinta Mountains.	Yes. Potential habitat for this species does not occur in the Project Area.

Species	Status[1]	Habitat Association	Potential for Occurrence Within the Proposed Monument Butte Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
Fringed myotis *Myotis thysanodes*	S SPC	A small bat that occurs in most of the western United States, as well as in much of Mexico and part of southwestern Canada. The species is widely distributed throughout Utah, but is not very common in the state. The fringed myotis inhabits caves, mines, and buildings, most often in desert and woodland areas.	Low. Based on the known range and the presence of suitable habitat, this species has the potential to occur in the Project Area.	**No. Potential habitat for this species occurs in the Project Area.**
Kit fox *Vulpes macrotis*	S SPC	Native to much of the western United States and northern Mexico. Although the species is not overly abundant in Utah, it does occur in the western, east-central, and southeastern areas of the state. The kit fox opportunistically eats small mammals (primarily rabbits and hares), small birds, invertebrates, and plant matter. The species is primarily nocturnal, but individuals may be found outside of their dens during the day. The species most often occurs in open prairie, plains, and desert habitats.	None. Suitable habitat for this species does not exist in the project area.	Yes. Potential habitat for this species does not occur in the Project Area.
Spotted bat *Euderma maculatum*	S SPC	Inhabits desert shrub, sagebrush-rabbitbrush, Pinyon-juniper woodland, and ponderosa pine and montane forest habitats. In Utah, the species also uses lowland riparian and montane grassland habitats. Suitable cliff habitat typically appears to be necessary for roosts/hibernacula. Spotted bats typically do not migrate and use hibernacula that maintain a constant temperature above freezing from September through May. Hibernation (in caves) and winter activity have been documented in southwestern Utah.	Low. The species potentially occurs throughout Utah; however, no occurrence records exist for the extreme northern or western parts of the state. Known occurrences have been reported in northeastern Uintah County.	**No. Potential habitat for this species occurs in the Project Area.**
Townsend's big-eared bat *Corynorhinus townsendii*	S SPC	Inhabits a wide range of habitats from semi desert shrublands and piñon-juniper woodlands to open montane forests. Roosting occurs in mines and caves, in abandoned buildings, on rock cliffs, and occasionally in tree cavities. Foraging occurs well after dark over water, along margins of vegetation, and over sagebrush.	Low. The species occurs throughout much of Utah including Duchesne and Uintah counties. Relative to the project area, one individual was collected at the Ouray National Wildlife Refuge in 1980.	**No. Potential habitat for this species occurs in the Project Area.**

Species	Status[1]	Habitat Association	Potential for Occurrence Within the Proposed Monument Butte Project Area and Cumulative Effects Area	Eliminated From Detailed Analysis? (Yes/No)
White-tailed prairie dog *Cynomys leucurus*	S SPC	White-tailed prairie dogs are typically found in open shrublands, semi-desert grasslands, and mountain valleys, where they occur in loosely organized colonies that may occupy hundreds of acres on favorable sites. Similar to other prairie dogs, white-tailed prairie dogs spend much of their time in underground burrows, often hibernating during the winter.	High. According to prairie dog colony mapping, approximately 9,372 acres of prairie dog colonies are located in the Project Area.	**No. This species is known to occur in the Project Area.**
Reptiles				
Cornsnake *Elaphe guttata*	S SPC	An isolated population occurs in western Colorado and eastern Utah. Usually found near streams, or in rocky or forest habitats. This species is typically more active at night.	None. Typical habitats for this species do not occur in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.
Smooth greensnake *Opheodrys vernalis*	S SPC	Typically inhabits meadows, grassy marshes, and moist grassy fields along forest edges. Its distribution ranges from northeastern Utah into central Colorado and northern New Mexico, and into the Northern Plains from the Canadian border south to Kansas and Missouri.	None. Typical habitats for this species do not occur in the Project Area.	Yes. Potential habitat for this species does not occur in the Project Area.

[1] Status: E = Federally listed as endangered; T = Federally listed as threatened; C = Federal candidate species; P = Federal proposed species; S = BLM sensitive species, Vernal Field Office; SPC = Wildlife species of concern; CS = Species receiving special mgmt. under a Conservation Agreement to preclude the need for Federal listing; BGEPA = Bald and Golden Eagle Protection Act.

Source: Adapted from BLM Vernal Field Office, Special Status Fish and Wildlife Species List (UDWR 2011b).
Source: UNHP-UDWR 2007, UNPS 2007.

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ATTACHMENT C Erosion and Sediment Load Estimation

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EROSION AND SEDIMENT LOAD ESTIMATION

For the purposes of this analysis, we have defined erosion as the process by which soil particles are mobilized and sediment load is the amount of eroded material that enters a stream channel. Sediment delivery ratio is the fraction of eroded material that enters a stream as the sediment load. While erosion can occur due to the action of wind, water, or glaciers, the Soils and Water Resources sections of this report are primarily concerned with erosion caused by water. Erosion was assumed to occur from four sources: 1) general soil erosion occurring throughout the watersheds, 2) well pads and facilities, 3) roads at stream crossings, and 4) roads throughout the remainder of the MBPA. The sediment load was assumed to occur from three sources: 1) general soil erosion occurring throughout the watersheds, 2) well pads and facilities, and 3) roads at stream crossings. It was assumed that sediment eroded from roads that were greater than 300 feet from a stream did not reach the stream and therefore, was not considered as a sediment load to the stream.

General soil erosion was estimate by acquiring sediment yield coefficients from a literature search on studies that were performed in northeast Utah. From these studies, we were able to estimate the sediment yield from combinations of vegetation and soil erodibility. The vegetation types were obtained from vegetation maps discussed in **Section 3.7** of this EIS. Soil erodibility categories (Low, Medium, and High) were generated from Water Erosion Potential values obtained from the Natural Resources Conservation Service (NRCS) GIS database. While sediment yield is a measure of the quantity of soil delivered to a watershed's stream, in this case we are also assuming that the watershed's sediment yield is also the amount of erosion occurring in the watershed. **Table C-1** provides a list of the sediment yield coefficients used in the analysis. **Tables C-2** through **C-5** show the general watershed erosion and sediment load occurring in each watershed.

C-1. Sediment Yield Coefficient

Land Cover	Soil Erodibility	Sediment Yield Coefficient (acre-feet/sq.mi./year)
Pinyon Juniper	Low	0.2
Riparian	Low	0.1
Sagebrush	Low	0.3
Desert Shrub	Low	0.4
Badlands	Low	0.5
Pinyon Juniper	Medium	0.4
Riparian	Medium	0.2
Sagebrush	Medium	0.6
Desert Shrub	Medium	0.9
Badlands	Medium	1.2
Pinyon Juniper	High	0.7
Riparian	High	0.3
Sagebrush	High	1.0
Desert Shrub	High	1.5

Badlands	High	2.0
Water or Rock	-	0.0

C-2. Erosion and Sediment Yield from General Erosion for Antelope Creek Watershed

Land Cover	Soil Erodibility	Area (acres)	Sediment Yield Coefficient (acre-feet/sq.mi./year)	Sediment Yield (tons/year)	Delivery Ratio	Erosion (tons/year)
Pinyon Juniper	Low	-	0.2	0	100%	0
Riparian	Low	-	0.1	0	100%	0
Sagebrush	Low	35	0.3	32	100%	32
Desert Shrub	Low	105	0.4	129	100%	129
Badlands	Low	-	0.5	0	100%	0
Pinyon Juniper	Medium	-	0.4	0	100%	0
Riparian	Medium	-	0.2	0	100%	0
Sagebrush	Medium	-	0.6	0	100%	0
Desert Shrub	Medium	10	0.9	28	100%	28
Badlands	Medium	-	1.2	0	100%	0
Pinyon Juniper	High	-	0.7	0	100%	0
Riparian	High	-	0.3	0	100%	0
Sagebrush	High	-	1.0	0	100%	0
Desert Shrub	High	-	1.5	0	100%	0
Badlands	High	-	2.0	0	100%	0
Water or Rock	-	-	0.0	0	100%	0
Total	**-**	**151**	**-**	**189**	**-**	**189**

Assume that soil density is 90 lbs. per cubic foot.

Table C-3. Erosion and Sediment Yield from General Erosion for Upper Pariette Draw Watershed

Land Cover	Soil Erodibility	Area (acres)	Adjusted Area (1) (acres)	Sediment Yield Coefficient (acre-feet/sq.mi./year)	Sediment Yield (tons/year)	Delivery Ratio	Erosion (tons/year)
Pinyon Juniper	Low	3,847	3,847	0.2	2,356	100%	2,356
Riparian	Low	-	-	0.1	0	100%	0
Sagebrush	Low	14,032	14,032	0.3	12,893	100%	12,893
Desert Shrub	Low	11,011	11,011	0.4	13,490	100%	13,490
Badlands	Low	914	914	0.5	1,400	100%	1,400
Pinyon Juniper	Medium	0	0	0.4	0	100%	0
Riparian	Medium	-	-	0.2	0	100%	0
Sagebrush	Medium	1,060	1,060	0.6	1,949	100%	1,949
Desert Shrub	Medium	9,874	9,874	0.9	27,217	100%	27,217
Badlands	Medium	19	19	1.2	72	100%	72
Pinyon Juniper	High	-	-	0.7	0	100%	0
Riparian	High	-	-	0.3	0	100%	0
Sagebrush	High	-	-	1.0	0	100%	0
Desert Shrub	High	22	22	1.5	102	100%	102
Badlands	High	-	-	2.0	0	100%	0
Water or Rock	-	-	65	0.0	0	100%	0
Total	**-**	**40,780**	**40,845**	**-**	**59,479**	**-**	**59,479**

(1) The individual areas did not sum to the total area of the watershed so the areas were adjusted.
Assume that soil density is 90 lbs. per cubic foot.

Table C-4. Erosion and Sediment Yield from General Erosion for Sheep Wash-Green River Watershed

Land Cover	Soil Erodibility	Area (acres)	Adjusted Area (1) (acres)	Sediment Yield Coefficient (acre-feet/sq.mi./year)	Sediment Yield (tons/year)	Delivery Ratio	Erosion (tons/year)
Pinyon Juniper	Low	-	-	0.2	0	100%	0
Riparian	Low	3	3	0.1	1	100%	1
Sagebrush	Low	338	338	0.3	311	100%	311
Desert Shrub	Low	3,384	3,384	0.4	4,146	100%	4,146
Badlands	Low	398	398	0.5	610	100%	610
Pinyon Juniper	Medium	-	-	0.4	0	100%	0
Riparian	Medium	13	13	0.2	8	100%	8
Sagebrush	Medium	63	63	0.6	116	100%	116
Desert Shrub	Medium	6,336	6,336	0.9	17,466	100%	17,466
Badlands	Medium	46	46	1.2	170	100%	170
Pinyon Juniper	High	-	-	0.7	0	100%	0
Riparian	High	-	-	0.3	0	100%	0
Sagebrush	High	-	-	1.0	0	100%	0
Desert Shrub	High	-	-	1.5	0	100%	0
Badlands	High	-	-	2.0	0	100%	0
Water or Rock	-	14	35	0.0	0	100%	0
Total	**-**	**10,596**	**10,617**	**-**	**22,827**	**-**	**22,827**

(1) The individual areas did not sum to the total area of the watershed so the areas were adjusted.
Assume that soil density is 90 lbs. per cubic foot.

Table C-5. Erosion and Sediment Yield from General Erosion for Lower Pariette Draw Watershed

Land Cover	Soil Erodibility	Area (acres)	Adjusted Area (1) (acres)	Sediment Yield Coefficient (acre-feet/sq.mi./year)	Sediment Yield (tons/year)	Delivery Ratio	Erosion (tons/year)
Pinyon Juniper	Low	2	2	0.2	1	100%	1
Riparian	Low	-	-	0.1	0	100%	0
Sagebrush	Low	19,137	19,137	0.3	17,584	100%	17,584
Desert Shrub	Low	16,908	16,908	0.4	20,714	100%	20,714
Badlands	Low	2,329	2,329	0.5	3,567	100%	3,567
Pinyon Juniper	Medium	-	-	0.4	0	100%	0
Riparian	Medium	-	-	0.2	0	100%	0
Sagebrush	Medium	1,742	1,742	0.6	3,201	100%	3,201
Desert Shrub	Medium	27,255	27,255	0.9	75,130	100%	75,130
Badlands	Medium	555	555	1.2	2,039	100%	2,039
Pinyon Juniper	High	-	-	0.7	0	100%	0
Riparian	High	-	-	0.3	0	100%	0
Sagebrush	High	-	-	1.0	0	100%	0
Desert Shrub	High	-	-	1.5	0	100%	0
Badlands	High	-		2.0	0	100%	0
Water or Rock	-	148	202	0.0	0	100%	0
Total	-	**68,077**	**68,131**	-	**122,237**	-	**122,237**

(1) The individual areas did not sum to the total area of the watershed so the areas were adjusted.
Assume that soil density is 90 lbs. per cubic foot.

Created by the NRCS, the Revised Universal Soil Loss Equation 2 (RUSLE2) computer program was used to estimate erosion from well pads. A typical well pad configuration was developed. Each well pad was assumed to be 475 feet long by 225 feet wide with a one percent slope. There was assumed to be five-foot high cut slope at a 3:1 slope at one end and a five-foot high fill slope at a 3:1 slope at the other end. The erosion from the pad was estimated for pads located on the four soil types found in the GMPA: loam, silt loam, sandy loam, and clay loam. It was assumed that all pads were constructed using the required erosion and sediment control Best Management Practices (BMPs), including a berm along the top edge of the pad and a sedimentation basin to capture sediment before it leaves the site. The RUSLE2 program estimated the erosion from the pad and also the reduction of the sediment load due to the BMPs that will be used. The typical pad erosion and sediment load estimate from each soil type was multiplied by the total number of pads located in a particular soil type and in each watershed to obtain an estimate of the erosion and sediment load in each watershed.

In addition, some existing pads will be expanded. It was assumed that the typical pad expansion would be about 0.2 acres or about 10 percent of the area of a new pad. It was assumed that the erosion and sediment load rate was proportional to the area of the pad; therefore, the erosion and sediment load from the portion of the new expanded pad was assumed to be 10 percent of a new pad. It was assumed that there would be no erosion or sediment load from existing pads because they would have undergone interim reclamation. Disturbed areas would have either been revegetated or graveled, so there would essentially be no erosion from the site. **Table C-6** provides the estimated erosion and sediment load from well pads in each watershed.

Table C-6. Sediment Yield from Pad Erosion per Watershed for Alternative D

Watershed	Soil Type	# of New Pads	# of Expanded Pads	Erosion per Pad for New Pads (1) (tons/year)	Erosion per Pad for Expanded Pads (2) (tons/year)	Length of Construction and Development Phase (years)	Erosion (3) (tons/year)	Sediment Delivery From Each New Pad (tons/year)	Sediment Delivery From Each Expanded Pad (tons/year)	Total Sediment Delivery from Pads (tons/year)	Delivery Ratio To Stream (4)	Sediment Yield To Stream (tons/year)
Antelope Creek	Loam	0	0	0.044	0.0044	16	0.00	0.0019	0.0002	0.0000	0.1	0.0000
Antelope Creek	Clay Loam	0	0	0.024	0.0024	16	0.00	0.0019	0.0002	0.0000	0.1	0.0000
Antelope Creek	Silty Loam	0	0	0.059	0.0059	16	0.00	0.0029	0.0003	0.0000	0.1	0.0000
Antelope Creek	Sandy Loam	4	0	0.039	0.0039	16	0.01	0.0010	0.0001	0.0003	0.1	0.0000
Subtotal		4	0				0.01			0.0003		0.0000
Lower Pariette Draw	Loam	190	194	0.044	0.0044	16	0.58	0.0019	0.0002	0.0253	0.1	0.0025
Lower Pariette Draw	Clay Loam	18	16	0.024	0.0024	16	0.03	0.0019	0.0002	0.0023	0.1	0.0002
Lower Pariette Draw	Silty Loam	96	61	0.059	0.0059	16	0.37	0.0029	0.0003	0.0187	0.1	0.0019
Lower Pariette Draw	Sandy Loam	395	625	0.039	0.0039	16	1.12	0.0010	0.0001	0.0286	0.1	0.0029
Subtotal		699	896				2.10			0.0749		0.0075
Sheep Wash-Green River	Loam	58	4	0.044	0.0044	16	0.16	0.0019	0.0002	0.0070	0.1	0.0007
Sheep Wash-Green River	Clay Loam	22	8	0.024	0.0024	16	0.03	0.0019	0.0002	0.0027	0.1	0.0003
Sheep Wash-Green River	Silty Loam	32	7	0.059	0.0059	16	0.12	0.0029	0.0003	0.0060	0.1	0.0006
Sheep Wash-Green River	Sandy Loam	120	11	0.039	0.0039	16	0.30	0.0010	0.0001	0.0076	0.1	0.0008
Subtotal		232	30				0.61			0.0233		0.0023
Upper Pariette Draw	Loam	25	109	0.044	0.0044	16	0.10	0.0019	0.0002	0.0043	0.1	0.0004
Upper Pariette Draw	Clay Loam	4	4	0.024	0.0024	16	0.01	0.0019	0.0002	0.0005	0.1	0.0001
Upper Pariette Draw	Silty Loam	18	35	0.059	0.0059	16	0.08	0.0029	0.0003	0.0039	0.1	0.0004
Upper Pariette Draw	Sandy Loam	262	463	0.039	0.0039	16	0.75	0.0010	0.0001	0.0193	0.1	0.0019
Subtotal		309	611				0.94			0.0281		0.0028
Total		**1244**	**1537**				**3.65**			**0.1265**		**0.0127**

(1) Assumes that typical pad area size is 2.45 acres
(2) Assumes that expanded area is about 10% of the new pad area so erosion is 10% that of new pad.
(3) Assumes that 1/16th of the total number of wells are constructed each year during the construction and development phase and that each well pad is “disturbed” for one (1) year until it is reclaimed and additional erosion over background erosion ceases. (4) Assumes that 10% of the sediment leaving the pad site is delivered to a stream.
One pad location is located on ‘No Soil’.

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Developed by the U.S. Forest Service, the Water Erosion Prediction Project (WEPP) Road model was used to estimate erosion and the sediment load from dirt roads and at road stream crossings. A sample of road stream crossings were randomly chosen for each type of soil, and the longitudinal slope and width of the road at each sample crossing was measured. It was assumed that erosion from the road occurred within 300 feet of each side of the stream and that 100 percent of the eroded material entered the stream (erosion=sediment load). Road traffic also influences the rate of erosion and sediment load. It was assumed that during the construction and development phase of well construction, road traffic would be "low," and that during the production phase, road traffic would be "none." The program was developed for forest service logging roads. Consequently, the use values are relative to what may occur on a typical logging road on forest service land. The erosion and sediment load was calculated at each location using WEPP Roads, and the results were averaged to provide an average erosion and sediment load at a crossing located in each type of soil. These average erosion and sediment load estimates were then multiplied by the number of crossings in each soil type in each watershed to estimate the erosion and sediment contribution from road stream crossings. **Table C-10** contains the erosion and sediment load estimates for existing conditions. **Table C-11** supplies the erosion and sediment load estimates during the construction and development phase for Alternative D. **Table C-12** provides the erosion and sediment load estimates during the production phase for Alternative D.

Table C-10. Sediment Yield from Stream Crossing Erosion for Existing Conditions

Watershed	Soil Texture	# of Stream Crossings	Erosion per Crossing (lbs/year)	Erosion (tons/year)	Delivery Ratio	Sediment Yield (tons/year)
Antelope Creek	Clay Loam	0	38.2	0.0	1	0.0
Antelope Creek	Loam	0	84.3	0.0	1	0.0
Antelope Creek	Sandy Loam	0	33.5	0.0	1	0.0
Antelope Creek	Silt Loam	0	279.2	0.0	1	0.0
Subtotal		0		0.0		0.0
Lower Pariette Draw	Clay Loam	25	38.2	0.5	1	0.5
Lower Pariette Draw	Loam	117	84.3	4.9	1	4.9
Lower Pariette Draw	Sandy Loam	247	33.5	4.1	1	4.1
Lower Pariette Draw	Silt Loam	38	279.2	5.3	1	5.3
Subtotal		427		14.9		14.9
Sheep Wash-Green River	Clay Loam	3	38.2	0.1	1	0.1
Sheep Wash-Green River	Loam	3	84.3	0.1	1	0.1
Sheep Wash-Green River	Sandy Loam	18	33.5	0.3	1	0.3
Sheep Wash-Green River	Silt Loam	10	279.2	1.4	1	1.4
Subtotal		34		1.9		1.9
Upper Pariette Draw	Clay Loam	14	38.2	0.3	1	0.3
Upper Pariette Draw	Loam	81	84.3	3.4	1	3.4
Upper Pariette Draw	Sandy Loam	179	33.5	3.0	1	3.0
Upper Pariette Draw	Silt Loam	11	279.2	1.5	1	1.5
Subtotal		285		8.2		8.2
Total		746		24.9		24.9

Note: It is assumed that the existing wells are in the production phase, so road use is negligible.
Assume that soil density is 90 lbs. per cubic foot.

Table C-11: Sediment Yield at Stream Crossing for Alternative D - Construction and Development Phase

Watershed	Soil Texture	# of Stream Crossings	Erosion per Crossing (lbs/year)	Erosion (tons/year)	Delivery Ratio	Sediment Yield (tons/year)
Antelope Creek	Clay Loam	0	128.0	0.0	1	0.0
Antelope Creek	Loam	0	212.3	0.0	1	0.0
Antelope Creek	Sandy Loam	0	48.8	0.0	1	0.0
Antelope Creek	Silt Loam	0	477.4	0.0	1	0.0
Subtotal		0		0.0		0.0
Lower Pariette Draw	Clay Loam	27	128.0	1.7	1	1.7
Lower Pariette Draw	Loam	169	212.3	17.9	1	17.9
Lower Pariette Draw	Sandy Loam	381	48.8	9.3	1	9.3
Lower Pariette Draw	Silt Loam	48	477.4	11.5	1	11.5
Subtotal		625		40.4		40.4
Sheep Wash-Green River	Clay Loam	8	128.0	0.5	1	0.5
Sheep Wash-Green River	Loam	11	212.3	1.2	1	1.2
Sheep Wash-Green River	Sandy Loam	44	48.8	1.1	1	1.1
Sheep Wash-Green River	Silt Loam	13	477.4	3.1	1	3.1
Subtotal		76		5.9		5.9
Upper Pariette Draw	Clay Loam	14	128.0	0.9	1	0.9
Upper Pariette Draw	Loam	95	212.3	10.1	1	10.1
Upper Pariette Draw	Sandy Loam	220	48.8	5.4	1	5.4
Upper Pariette Draw	Silt Loam	16	477.4	3.8	1	3.8
Subtotal		345		20.2		20.2
Total		1046		66.4		66.4

Assume that soil density is 90 lbs. per cubic foot.

Table C-12: Sediment Yield at Stream Crossing for Alternative D - Production Phase

Watershed	Soil Texture	# of Stream Crossings	Erosion per Crossing (lbs/year)	Erosion (tons/year)	Delivery Ratio	Sediment Yield (tons/year)
Antelope Creek	Clay Loam	0	38.2	0.0	1	0.0
Antelope Creek	Loam	0	84.3	0.0	1	0.0
Antelope Creek	Sandy Loam	0	33.5	0.0	1	0.0
Antelope Creek	Silt Loam	0	279.2	0.0	1	0.0
Subtotal		0		0.0		0.0
Lower Pariette Draw	Clay Loam	27	38.2	0.5	1	0.5
Lower Pariette Draw	Loam	169	84.3	7.1	1	7.1
Lower Pariette Draw	Sandy Loam	381	33.5	6.4	1	6.4
Lower Pariette Draw	Silt Loam	48	279.2	6.7	1	6.7
Subtotal		625		20.7		20.7
Sheep Wash-Green River	Clay Loam	8	38.2	0.2	1	0.2
Sheep Wash-Green River	Loam	11	84.3	0.5	1	0.5
Sheep Wash-Green River	Sandy Loam	44	33.5	0.7	1	0.7
Sheep Wash-Green River	Silt Loam	13	279.2	1.8	1	1.8
Subtotal		76		3.2		3.2
Upper Pariette Draw	Clay Loam	14	38.2	0.3	1	0.3
Upper Pariette Draw	Loam	95	84.3	4.0	1	4.0
Upper Pariette Draw	Sandy Loam	220	33.5	3.7	1	3.7
Upper Pariette Draw	Silt Loam	16	279.2	2.2	1	2.2
Subtotal		345		10.2		10.2
Total		1046		34.1		34.1

Note: It is assumed that road use will be negligible during the production phase.

Erosion from roads outside of the stream crossings were also estimated using WEPP:Road. It was assumed that the roads were "outsloped" and runoff would flow off the side of the road and down the embankment, carrying eroded material with it. As previously mentioned, it was assumed that the eroded material would be deposited at the base of the fill slope and would not be transported to a stream so there was no sediment load generated by this erosion source. **Table C-13** contains the erosion estimate for existing conditions. **Table C-14** presents the erosion estimates for Alternative D.

Table C-13. Estimated Road Erosion for Existing Conditions

Soil Texture	Road Width (feet)	Road Slope from Left (%)	Road Length (feet)	Climate Station	Rock %	Road Design	Fill Gradient (%)	Fill Length (feet)	Buffer Gradient (%)	Buffer Length (feet)	Road Surface	Traffic Level	Simulation Period (years)	Unit Erosion (pounds/year/100' of road) Construction and Development Phase	Unit Erosion (pounds/year/100' of road) Production Phase	Total Road Length (100 feet)	Total Erosion (tons/year) Construction and Development Phase	Total Erosion (tons/year) Production Phase
Clay Loam	23.4	0.82%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	9.11	13.42	1,100	5.0	7.4
Loam	22.2	1.48%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	11.38	15.93	7,224	41.1	57.5
Sandy Loam	22.4	4.12%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	4.59	5.97	21,573	49.5	64.4
Silty Loam	27.0	4.60%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	17.61	21.01	2,741	24.1	28.8
TOTAL																	**119.8**	**158.1**

Minimum Road Slope is 0.3%

Table C-14. Estimated Road Erosion for Alternative D

Soil Texture	Road Width (feet)	Road Slope from Left (%)	Road Length (feet)	Climate Station	Rock %	Road Design	Fill Gradient (%)	Fill Length (feet)	Buffer Gradient (%)	Buffer Length (feet)	Road Surface	Traffic Level	Simulation Period (years)	Unit Erosion (pounds/year/100' of road) Construction and Development Phase	Unit Erosion (pounds/year/100' of road) Production Phase	Total Road Length (100 feet)	Total Erosion (tons/year) Construction and Development Phase	Total Erosion (tons/year) Production Phase
Clay Loam	23.4	0.82%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	9.11	13.42	1,478	6.7	9.9
Loam	22.2	1.48%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	11.38	15.93	9,728	55.4	77.5
Sandy Loam	22.4	4.12%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	4.59	5.97	29,413	67.5	87.8
Silty Loam	27.0	4.60%	300	Altamont, UT	10	Outsloped, unrutted	50	10	1	1000	Native	Low	50	17.61	21.01	3,928	34.6	41.3
TOTAL																	**164.2**	**216.5**

Minimum Road Slope is 0.3%

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ATTACHMENT D Greater Monument Butte Unit Reclamation and Weed Management Plan

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INTRODUCTION

The purpose for this document is to amend the previously approved *Newfield Exploration Company Castle Peak and Eight Mile Flat Reclamation and Weed Management Plan* (Newfield 2009) which was written to comply with Instruction Memorandum No. GR-2009-002. This amendment is intended to more accurately comply with revised BLM Instruction Memorandum UTG000-2011-003 regarding BLM adoption of the 2011 revised *Green River District Reclamation Guidelines.* In addition, this amendment more accurately defines Newfield's reclamation techniques and monitoring efforts that have been refined to more adequately address these policy changes. The need of this amendment came from examining recent NEPA analyses and BLM Decision Records that referred to conformance with Newfield's previously referenced plan which is no longer consistent with the current BLM policy.

RELATION TO STATUTES, REGULATIONS, AND GUIDELINES

The proposed reclamation plan amendment is consistent with the following Federal Statutes, Regulations, Guidelines and Decisions:

- Onshore Oil and Gas Order Number 1 Section III.B.4J. *Plans for Surface Reclamation*
- *Surface Operating Standards for Oil and Gas Exploration and Development* or "Goldbook" (BLM and USFS 2007)
- Standards for Rangeland Health and Guidelines for Grazing Management for BLM Lands in Utah (BLM 1997)
- Green River District Reclamation Guidelines 2011 IM UTG000-2011-003
- Record of Decision for Newfield Exploration Company's Castle Peak and Eightmile Flat Oil and Gas Development Environmental Impact Statement (2005)

APPLICABLE AREA

This Reclamation Plan Amendment would apply to BLM lands within the Greater Monument Butte Unit and outlines procedures and measures that would be taken to initiate reclamation on all areas that have been authorized for disturbance applicable to *IM UTG000-2011-003.*

The Green River Reclamation Guidelines define **Interim Reclamation** as ***the minimizing of the footprint of disturbance by reclaiming all portions of the well site not needed for safe production operations. The portions of the well site not needed for operational and safety purposes would be recontoured to a final appearance that blends with the surrounding topography. Topsoil would be spread over these areas. The operator would spread the topsoil over the entire location except where an all-weather surface, access route or turnaround is needed. Production facilities should be clustered or placed offsite to maximize the opportunity for interim reclamation. Any incidental use on interim reclamation may require restoration of damage. This may require recontouring and seeding of the damaged area.***

As oil and gas operations may result in surface disturbing activities beyond those described in the Vernal BLM's **Interim Reclamation** definition, Newfield would like to define their interim reclamation capabilities and limitations as part of this amendment.

Areas of Interim Reclamation Potential

- All pipeline corridors resulting in surface disturbance
- All reserve pits
- Portions of well pads following installation of flowlines that would allow removal of separators, heater-treaters, and/or storage tanks
- Portions of the well pad not needed for workover and production operations (i.e., minimum of 1 ac)

RECLAMATION STRATEGY

In addition to general footprint minimization, the following reclamation actions would be conducted by Newfield to meet the short term goal: (***immediately stabilize disturbed areas and to provide the necessary conditions to achieve the long term goal***); and long term goal: (***facilitate eventual ecosystem reconstruction by returning the land to a safe, stable, and proper functioning condition***); as well as the eight reclamation objectives and associated actions outlined in the 2011 Green River District Reclamation Guidelines.

Objective 1 - Establish a desired self-perpetuating plant community.

The objective is to attain 75% basal cover based on similar undisturbed adjacent native vegetative community, and comprised of desired species and/or seeded species within 5 years of initial reclamation action. Species diversity should approximate the surrounding undisturbed area. For areas that are in poor range condition due to past land management practices, then the species diversity should approximate the site as described in the NRCS Ecological Site description. However if after three (3) growing seasons there is less than 30% of the basal cover based on similar undisturbed native vegetative community, then the Authorized Officer may require additional reclamation efforts.

Seed Mix

In cooperation with the BLM Authorized Officer, Newfield would determine a seed mix for the project area. A diversified selection of native seeds found local to the project area would be used. Locally harvested seed would be sought to the greatest extent possible; however seed selection would largely be influenced by market availability. Non-native species would be used in moderation and mixed in low concentrations with natives to assist in initial plant establishment. All use of non-native seed would be authorized by BLM Authorized Officer.

Seed Storage

Seed would be stored in a cool dry place ensuring proper storage required to keep seed viable. All seed utilized would be tested prior to application to ensure BLM specifications for pure live seed (PLS), purity, noxious weeds, etc. have been met. Seed tags would be provided to the Authorized Officer as requested.

Seed Placement

Proper care would be taken to plant assorted sized seeds to proper depths, usually 5 times the width of the seed. Seed would be placed at the correct depth providing good contact between seed and soil. The correct depth of planting would be deep enough to allow seed to take up water, to protect it from desiccation or birds, and to prevent it from germinating with light rains, yet shallow enough to allow the seedling to reach the surface before depleting food reserves or being attacked by insects or disease.

Seedbed Preparation

Newfield would alleviate compaction for root establishment prior to seeding. Seedbeds would also be constructed to physically hold as much water as possible. Rippers, harrows, disks, chisel plows or similar equipment would be used to loosen soil and alleviate compaction. After loosening to desirable depths and after topsoil is reapplied soils may be imprinted and or pocketed. Pockets create microclimates which protect small emerging seedlings, increase soil holding capacity, and decrease runoff and erosion. Imprinting has been found to be successful in the arid climates of Utah. "Seedling emergence was improved by imprinting compared to drilling in Utah." (Clary and Johnson 1983)

Seeding Method

Various seeding techniques including, broadcasting, broadcast/harrow, broadcast/press, and drilling would be used to place seed to optimal depths. Seeding rates would range from 18 to 20 PLS lbs per acre or as prescribed by BLM Authorized Officer.

Seeding Season

Newfield would apply seed between late fall and early spring depending on moisture, ground temperature, and snow cover. Newfield has proven success with winter seeding. Certain species of seed require early spring/winter application for optimal effectiveness.

Mulching

In some cases, Newfield may apply certified weed free straw and crimped in attempt to capture and hold moisture, stabilize soil, provide organic matter, and protect seed. Newfield may also grow an annual grain to reestablish and stabilize soils in late spring/summer months. Such efforts would combat weed growth, supply subsurface organic matter, oxygenate soil, alleviate compaction, and minimize runoff.

Slopes

Areas in excess of 40% slope or are excessively rocky would be amended as safely as possible. Seed rates would in these areas may be increased as necessary. Seed may be broadcast and covered by harrowing, drag bar, roller, or as determined effective and safe by Newfield and BLM Authorized Officer.

Amendments

If initial reclamation activities are unsuccessful, Newfield would amend soils to meet the long-term goals of restoration. Potential soil amendments may include: topsoil, compost, woodchips, wood-pulp, straw, elemental sulfur or other safe acids, gypsum, fertilizer, slow release fertilizer, humus, or any other amendments which prove effective in combating saline/sodic soil characteristics typical of harsh western desert environments.

As determined and in cooperation with the BLM Authorized Officer, fencing may be used to exclude livestock/big game grazing until seeded species have become established. Fencing would be constructed to BLM standards.

Objective 2 - Ensure slope stability and topographic diversity

Newfield would reconstruct disturbed areas to the approximate original contour or to assure the site looks natural or blends with the surrounding terrain.

Where applicable, Newfield would imprint, step down, or lesson slope on steep terrain in effort to control erosion. Perimeter berms may be used on well pads to control site rainwater runoff erosion of site fill material. Summer grown mulch and imprinting may also be considered to help control erosion while simultaneously competing against weeds between desirable seeding windows.

Objective 3 - Reconstruct and stabilize altered water courses and drainage features

Newfield would reconstruct drainage basins to have similar features and hydraulic characteristics found in nearby properly functioning drainages. Pads would be designed to divert water flow around, to keep water off, and to redirect the water back into the established natural watercourse.

Objective 4 - Ensure the biological, chemical, and physical integrity of the topsoil resource during all phases of construction, operation, and reclamation.

BMP's designed to minimize and prevent erosion, compaction, and contamination of the topsoil resource should be used to maintain the topsoil resource.

Topsoil Stripping/Storage

Prior to excavation of subsoil all topsoil would be stripped. Topsoil would be windrowed parallel to disturbance and great care would be taken to segregate topsoil from subsoils. During topsoil stockpiling Newfield would avoid slopes, natural drainage ways, and traffic routes. All topsoil stored beyond one season would be gently compacted to an acceptable height to ensure viability and imprinted/mulched and seeded to reduce erosion and to ensure the long-term viability of the resource. Newfield would identify topsoil storage with appropriate signage to prevent improper use.

Redistribution of Topsoil

To the greatest extent possible, soils would be reapplied as they were extracted. With permission of the BLM Authorized Officer topsoil may be moved from site while still viable to use on similar sites with similar soil characteristics.

Objective 5 - Re-establish the visual composition and characteristics to blend with the natural surroundings.

Newfield would reconstruct disturbed areas to the approximate original contour or to assure the site looks natural or blends with the surrounding terrain.

Objective 6 - Control the occurrences of noxious weeds and undesirable invasive species by utilizing principles of integrated weed management including prevention, mechanical, chemical, and biological control methods.

A pre disturbance noxious weed inventory shall be conducted on all surface disturbing projects to determine the presence of noxious weeds prior to beginning the project, and to determine whether treatment is needed prior to disturbance. If noxious weeds are found a report including:

- A GPS location recorded in North American Datum 1983
- Species
- Canopy Cover or number of plants
- General infestation size (estimate of square feet or acres)

Information shall be provided to the BLM Weed Coordinator prior to the disturbance occurring, and also documented in the annual reclamation report.

Newfield would conduct weed management and control by using a process called Integrated Weed Management (IWM). Integrated Weed Management is a process at which all possible means of weed control are utilized. The processes within IWM include cultural, mechanical and chemical methods.

- Cultural methods include changing operations where possible to inhibit weed seed distribution through human means. Cultural changes could include quarantining certain "weedy" areas to only necessary traffic until treatments are completed, and washing vehicles more frequently.
- Mechanical methods may include mowing, tilling, or hand weeding small area of weed infestations.
- Chemical methods would include using commercial herbicides where required to keep weed infestations under control.

The use of grown mulch on reclaimable sites would effectively combat weeds during late spring/summer months.

Newfield would control any noxious and/or invasive weeds outbreak that is directly attributed to Newfield's activities.

Typical chemical treatments within the Green River District include bromacil, diuron, Dicamba, and Oust. The average application rate for these chemicals within the region is approximately 8.3 pounds per acre. An approved Pesticide Use Proposal (PUP) would be obtained for all planned herbicide applications. Herbicides would be applied by a certified applicator with a current Utah Pesticide Applicators License. A Biological Use Proposal is required for new bio-control agents in the Field Office area.

Objective 7 - Manage all waste materials

Newfield would segregate waste materials from the subsoil and topsoil.

All waste materials transported and disposed of off-site, would be placed in an authorized disposal facility in accordance with all local, State and Federal requirements.

Objective 8 – Conduct monitoring that is able to assess the attainment or failure of reclamation actions

Monitoring

Newfield would adhere to the Green River Guidelines 2011 monitoring guidelines as stated:

Monitoring methodology should be an approved BLM method designed to monitor basal vegetative cover. Monitoring criteria:

Qualitative monitoring data would be collected after the 2nd growing season following reclamation actions. Quantitative data would be collected after the 3rd and 5th growing seasons, and the year that the applicant determines that reclamation meets the long term objective of 75% basal cover as compared to the reference site.

- In areas where the reference site data shows less than 5% basal cover, and is due to past land management practices, then the objective for the disturbed area that is being reclaimed would be 5% basal cover after the third growing season, and 8% after the fifth growing season.
- Any one species should not account for more than 30% of the total measured basal cover.
- All ROW's would include a monitoring transect per each NRCS ecological site that the ROW passes through that is greater than 0.75 miles.
- General view photographs of the reclaimed areas would be submitted with the quantitative data. Photographs would be taken at the same photo point each time, and as close to the same time of year as previous photos were taken to reduce differences in plant growth characteristics.

In cooperation with the Authorized Officer, an undisturbed reference site should be selected prior to monitoring. One reference site may be used for multiple reclamation sites as long the site potentials are similar. Reference site criteria:

- Reference sites shall be permanently marked, and the location recorded by Global Positioning System (GPS) North American Datum 1983.
- For ROW's a reference site shall be established in each unique NRCS Ecological Site that the ROW passes through.
- A photograph consisting of a general view of the marked reference site should be submitted with the Reference site data.

Newfield would document and report monitoring data and recommend revised reclamation strategies, if necessary. Newfield would submit an annual reclamation report to the Authorized Officer. The report would document compliance with all aspects of the reclamation objectives and standards.

Newfield would implement revised reclamation strategies as needed.

Newfield would repeat the process of monitoring, evaluating, documenting/reporting, and implementing, until reclamation goals are achieved, as determined by the Authorized Officer.

ATTACHMENT E Water Quality Monitoring Plan

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E.1 INTRODUCTION

This Attachment provides an example of a possible long-term water quality monitoring plan (monitoring plan) for the Newfield Greater Monument Butte Oil & Gas Development Project Environmental Impact Statement (EIS).

E.1.1 Monitoring Objectives

The overall objective of the monitoring plan is to document changes in water quality and quantity that could occur to Greater Monument Butte Project Area (MBPA) streams and water sources (e.g. Pariette Draw, the Green River, groundwater, and springs) over the life of the project (LOP). Monitoring data and reports would be shared with the Utah Division of Oil Gas and Mining (UDOGM), the Utah Division of Water Quality (UDWQ) Groundwater Protection Section, and the UDWQ Watershed Management Section.

To account for uncertainty associated with data available for the Greater Monument Butte EIS, this monitoring plan is designed to detect unanticipated impacts to water resources associated with the project. These unanticipated impacts may include:

- Contamination of surface water and/or groundwater by accidental spills of fuels, lubricants, fluid used for hydraulic fracturing, produced petroleum products, downhole impacts to groundwater or surface water, and leakage from reserve pits;
- Increased sedimentation and turbidity of surface waters;
- Increased concentrations of selenium, boron, and salinity;
- Decreased flows from springs near development areas due to groundwater use by drilling operations; and/or
- Changes in groundwater level in water supply wells near development area due to groundwater use by drilling operations.

It should be noted that, as disclosed in the Greater Monument Butte EIS, none of these impacts are expected to occur. Best Management Practices (BMPs) and Applicant-Committed Environmental Protection Measures (ACEPMs) that were incorporated into the analysis should mitigate the potential for impacts to water resources.

E.1.2 Quality Assurance and Sampling Analysis Planning

The first step in the implementation of this monitoring plan would be to develop a comprehensive quality assurance project plan (QAPP), including a comprehensive sampling analysis plan (SAP). Newfield would fund a qualified hydrologist (hereafter referred to as the hydrologist) to develop the QAPP and SAP. The QAPP would be developed using Environmental Protection Agency (EPA) guidance (EPA 2001) and would document the planning, implementation, and assessment procedures for the project, including sampling methods, laboratory procedures, data management and analysis, and reporting. The QAPP would ensure data quality meets the required formats and standards that are required to be incorporated into the current UDWQ database. This step is necessary to ensure that data collected provides reliable detection of impacts to water resources in or downstream of the MBPA. The QAPP would be prepared prior to any sampling collection, including baseline sampling, prior to commencement of the project. Implementation of this plan would provide information for the BLM to identify, evaluate, document, and monitor direct, indirect, and cumulative impacts to water resources. This plan would also provide the BLM with the tools necessary to determine appropriate response and mitigation measures in the unlikely event of impacts to water resources. The QAPP would be reviewed by the BLM, EPA, and the State of Utah before being approved by the BLM.

Prior to commencement of the Greater Monument Butte project, baseline data would be collected in accordance with the QAPP and SAP for all parameters listed in **Tables E-2**, **E-4**, and **E-6** for surface water, springs, and groundwater, respectively. Data would be collected from appropriate monitoring sites, as described in **Sections E.3.1**, **E.3.2**, and **E.3.3**.

E.2 SUMMARY OF EXISTING WATER QUALITY DATA FOR THE MBPA

The Greater Monument Butte EIS includes available existing water quality data for surface water and shallow groundwater within the MBPA. Surface water quality data have been collected for some parameters at three locations on Pariette Draw, and the U.S. Geological Survey (USGS) and the State of Utah provide regular monitoring of the Green River upstream from the MBPA. No data are available for ephemeral streams within the MBPA.

The surface water data collected consist of the following parameters:

- **Physical:** pH, alkalinity, temperature, specific conductance, dissolved oxygen (DO), DO saturation, turbidity, salinity, hardness, total dissolved solids [TDS], and total suspended solids [TSS]
- **Nutrients:** Inorganic nitrogen (nitrate plus nitrite), total phosphorus, orthophosphate, ammonia, Kjeldahl-nitrogen, total organic carbon, chemical oxygen demand, and potassium
- **Metals:** Aluminum, barium, cadmium, chromium, calcium, copper, iron, lead, manganese, magnesium, mercury, nickel, selenium, silver, sodium, and zinc
- **Other:** Bicarbonate, boron, arsenic, carbonate, chloride, hydroxide, and sulfate

Analyses of petroleum constituents (e.g., benzene, toluene, ethylbenzene, xylenes, methane, and hydrogen sulfide) have not been previously performed for either surface or groundwater; and therefore, there is currently no existing data to compare to future water quality data. Because there is existing oil and gas development in the area, any anomalies identified in future samples could not be directly related to the Greater Monument Butte EIS project without sufficient baseline samples.

Flow measurements were made at four USGS continuous flow gaging stations located on Pariette Draw in the late 1970s and early 1980s. These include USGS gages 09307200, 09307290, 09307295, and 09307300. More recently, flow was measured on several occasions in conjunction with water quality sampling at the two Utah Storage and Retrieval (STORET) monitoring stations located on Pariette Draw. USGS flow and water quality data is also available at USGS Gage 09272400 at Ouray, Utah.

Groundwater quality data have been collected for one shallow groundwater well (Newfield Well) within the MBPA, located in the Eight Mile Flat area (Section 29, Township 9 South, Range 18 East). The well is approximately 300 feet deep with a depth to groundwater of approximately 75 feet. The data collected are limited to general water quality parameters, including TDS, pH, major cations (calcium, magnesium, sodium), major anions (bicarbonate, sulfate, chloride), several trace metals (iron and manganese), and dissolved gasses (carbon dioxide, hydrogen sulfide).

If available and where pertinent, water quality data collected as part of the Gasco Long-Term Monitoring Plan would be used. Similarly, where pertinent water quality data collected as part of this plan would be shared with Gasco.

E.3 MONITORING SITE SELECTION, TYPES OF MONITORING AND PROTOCOLS, AND MONITORING FREQUENCY

E.3.1 Surface Water Monitoring

In addition to the existing data available for the MBPA, baseline surface water samples would be collected prior to commencement of the Greater Monument Butte project at the existing locations identified in Table H-1, and at potential new monitoring locations discussed in more detail below. The baseline samples would include at least one sample collected per location under baseflow conditions, as defined in the QAPP. All surface water samples collected during the first year of sampling (including those collected after commencement of the Greater Monument Butte project) would serve as the surface water quality baseline data against which potential impacts would be measured.

Long-term monitoring of surface water quality would be conducted at the four existing Utah STORET surface water quality locations listed in **Table E-1** and shown on **Figure H-1**. In addition, the BLM would work with the UDWQ to install and operate new monitoring stations. Potential locations for new monitoring stations are identified in **Table E-1** and shown on **Figure H-1.** These potential monitoring station locations were identified using a watershed approach whereby each station was conceptually placed downstream of tributary areas as well as downstream from concentrated development (both existing and conceptually proposed development). The goal for the placement of proposed monitoring stations is to allow the BLM to collect surface water monitoring data representative of the entire project area.

Table E-1. Long-term Surface Water Quality Monitoring Stations for the Greater Monument Butte Long-term Water Resources Monitoring Plan

Water Body	STORET Number / Proposed Monitoring Station	Station Name
Existing Stations		
Pariette Draw	4933476	Below flood control (below Castle Peak Draw)
Pariette Draw	4933480	1/3 mile above flood control dam (P 1000)
Pariette Draw	4933440	1 mile above confluence with the Green River (P 2000)
Green River	4937020	Green River near Ouray
Proposed Stations		
1	Wells Draw	S23 T8S R16E
2	Castle Peak Draw	S5 T9S R17E
3	Lower Pariette Draw	S14 T9S R19E
4	Sheep Wash	T9S R19E
A	Unnamed	S24 T8S R15W

B	Castle Peak Draw	S4 T9S R17E
C	Big Wash	S1T9S R17E
D	Unnamed	½ mile upstream of confluence with Upper Pariette Draw

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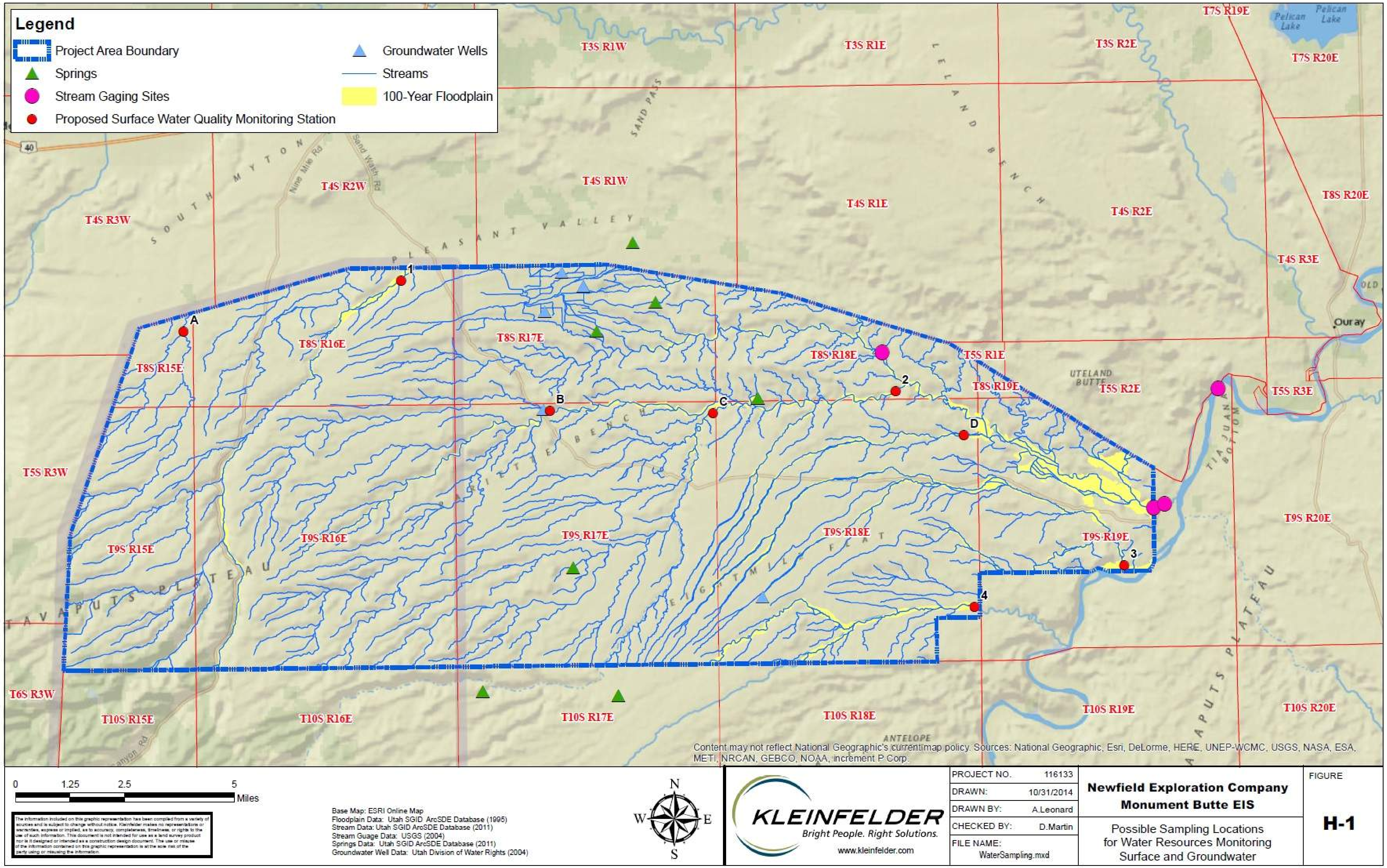
Legend
Project Area Boundary
Springs
Stream Gaging Sites
Proposed Surface Water Quality Monitoring Station
Groundwater Wells
Streams
100-Year Floodplain
0 1.25 2.5 5 Miles
Base Map: ESRI Online Map
Floodplain Data: Utah SGID ArcSDE Database (1995)
Stream Data: Utah SGID ArcSDE Database (2011)
Stream Guage Data: USGS (2004)
Springs Data: Utah SGID ArcSDE Database (2011)
Groundwater Well Data: Utah Division of Water Rights (2004)
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.
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FILE NAME: WaterSampling.mxd
Newfield Exploration Company
Monument Butte EIS
Possible Sampling Locations for Water Resources Monitoring Surface and Groundwater
FIGURE
H-1

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At each surface water monitoring site, field parameters would be measured, and a sample would be collected for analysis of the parameters listed in **Table E-2**. For all parameters, the detection limit for each individual analysis would be reported in a database.

Table E-2. Parameters for Long-term Surface Water Monitoring

Field and General Water Quality Parameters	Trace Metals	Other Inorganic Constituents	Organic Constituents
Total alkalinity	Aluminum	Ammonia	Volatile organic compounds (VOCs)[1]
Temperature	Barium	Arsenic	Semi-volatile organic compounds[2]
Specific conductance	Cadmium	Bicarbonate	Radionuclides
pH	Calcium	Boron	Total petroleum hydrocarbons[3]
DO	Chromium	Carbonate	Inorganic nitrogen
DO saturation	Copper	Chloride	Total phosphorus
Turbidity	Iron	Hydroxide	Potassium
Dissolved hardness	Lead	Sulfate	Orthophosphate
TDS	Manganese	–	Kjeldahl-nitrogen
TSS	Magnesium	–	Total organic carbon
Flow	Mercury	–	Chemical oxygen demand
Aquatic habitat	Nickel	–	–
Geomorphology	Selenium	–	–
–	Silver	–	–
–	Sodium	–	–
–	Zinc	–	–

1 VOCs would be analyzed using EPA Method 8260 or a fully equivalent standard method. Benzene would be analyzed at a detection limit of 1 microgram per liter or lower.

2 Semi-volatile organic compounds would be analyzed using EPA Method 8270 or a fully equivalent standard method.

3 Total petroleum hydrocarbons would include, at a minimum, analysis for diesel-range organics and gas-range organics.

Samples would be collected on a quarterly basis (one each in the winter, spring, summer, and fall), and one storm sample per year would be collected at each STORET site and the Green River site downstream of MBPA over the LOP. Storm events could also potentially be monitored at the following locations: 1) the draw exiting the project area in the NE 1/4 of T8S:RI6E, 2) upstream of the downstream convergence from STORET monitoring site in T8S:R18E close to line with T9SR18E, 3) the draw just upstream of the Green River in SE 1/4 T9S:RI9E and 4) the SE 1/4 of T9S:RI8E before the convergence with Green River. Storm events would be defined in the QAPP in terms of precipitation and/or flow. Flows at each site would be directly measured at the time each sample is collected. Depending on the magnitude of flow, measurements would be taken using the most appropriate method. The frequency of storm event monitoring would be determined by the BLM in coordination with the UDWQ.

E.3.2 Spring Monitoring

In addition to the existing data available for the MBPA, at least two but preferably three baseline spring water samples would be collected prior to commencement of the Greater Monument Butte project. All spring water samples collected during the first year of sampling (including those collected after commencement of the Greater Monument Butte project) would serve as the spring water quality baseline data against which potential impacts would be measured.

As discussed in Section 3.6.3.2 of the EIS there are only four known springs within the MBPA (**Table E-3**). Long-term monitoring of water quality at selected springs would be conducted at the four springs listed in **Table E-3** and shown on **Figure H-1**. The springs selected are located within the MBPA and have water rights associated with stock watering.

Table H-3. Long-term Spring Monitoring Locations

Spring Name and Number	Location	Water Rights Number
Unnamed Spring	Section 21, Township 9 South, Range 17 East	47-1332
Odekirk Spring	Section 31, Township 8 South, Range 18 East	47-1581
Pleasant Valley Seep	Section 23, Township 8 South, Range 17 East	47-1602
Felter Spring	Section 21, Township 8 South, Range 17 East	47-1439

At each spring monitoring location, field parameters would be measured, flows would be measured, and a sample would be collected for analysis of the parameters listed in **Table E-4**. For all parameters, the detection limit for each individual analysis would be reported in a database. The inclusion of detection limits would allow for the accurate calculation of mean concentrations for parameters with large numbers of non-detect values. Samples would be collected on a quarterly basis (one each in the winter, spring, summer, and fall) at each spring over the LOP.

Flows at spring locations would be measured as near to the spring source as possible; measurement methods would be the same as those described under surface water. If flow is too low for these methods, alternative methods to measure or estimate flow may be considered. Similarly, if flows are too low to sample, photographic records of spring conditions would be captured.

Table E-4. Parameters for Long-term Spring Monitoring

Field and General Water Quality Parameters	Trace Metals	Other Inorganic Constituents	Organic Constituents
Total Alkalinity	Aluminum	Ammonia	Volatile organic compounds (VOCs)[1]
Temperature	Barium	Arsenic	Semi-volatile organic compounds[2]
Specific Conductance	Cadmium	Bicarbonate	Radionuclides

pH	Calcium	Boron	Total petroleum hydrocarbons[3]

Field and General Water Quality Parameters	Trace Metals	Other Inorganic Constituents	Organic Constituents
DO	Chromium	Carbonate	Inorganic nitrogen
DO saturation	Copper	Chloride	Total phosphorus
Dissolved Hardness	Iron	Hydroxide	Potassium
TDS	Lead	Sulfate	Orthophosphate
Flow	Manganese	–	Kjeldahl-nitrogen
TSS	Magnesium	–	Total organic carbon
Turbidity	Mercury	–	Chemical oxygen demand
–	Nickel	–	–
–	Selenium	–	–
–	Silver	–	–
–	Sodium	–	–
–	Zinc	–	–

[1] VOCs would be analyzed using EPA Method 8260 or a fully equivalent standard method. Benzene would be analyzed at a detection limit of 1 microgram per liter or lower.

[2] Semi-volatile organic compounds would be analyzed using EPA Method 8270 or a fully equivalent standard method.

[3] Total petroleum hydrocarbons would include, at a minimum, analysis for diesel-range organics and gas-range organics.

E.3.3 Groundwater Monitoring

Baseline groundwater water samples would be collected at available and accessible[1] groundwater wells within the MBPS prior to commencement of the Greater Monument Butte project. Currently, there are five existing water wells within the project area. Assuming access is granted, all five of these wells would be sampled in advance of project initiation. All new water wells within the MBPA would also be sampled prior to project initiation or when the new well comes online (whichever comes first). Detailed monitoring protocols and final well selection would be identified in the QAPP and SAP prior to any drilling.

The purpose of the baseline monitoring network would be to 1) establish baseline groundwater quality for the major known aquifers in the area that could be impacted by drilling; 2) establish baseline groundwater quality for any freshwater aquifers and known drinking water sources in the area; and 3) establish monitoring points likely to be down-gradient of major project activities. All groundwater samples collected during the first year of sampling (including those collected after commencement of the Greater Monument Butte project) would serve as the groundwater quality baseline data against which potential impacts would be measured. The following three types of monitoring wells would be considered for selection:

- *Drinking water or stock use wells.* The hydrologist would conduct a search of water rights within the area (via the Utah Division of Water Rights) for any water rights that are used for either drinking water or stock water. These could be wells, springs, or other diversion types. Following the database search, the hydrologist would conduct site visits of the potential monitoring points to verify that there is sufficient access and infrastructure to use the wells for semi-permanent monitoring. If monitoring points appear to be constructed in a manner that would allow for periodic sampling, the landowner would be contacted for permission to sample and for additional details regarding well construction (e.g., depth, screened interval, drilling logs).
- *Existing monitoring well networks.* The hydrologist would conduct a search of water rights in the area to identify any existing monitoring well networks. Following the database search, the hydrologist would contact owners and determine if these wells are accessible, evaluate the possibility of obtaining permission for sampling, and obtain additional construction details.
- *Other non-potable wells.* The hydrologist would identify additional non-potable wells in the area (likely through companies currently conducting oil and gas exploration) by directly contacting other oil and gas operators in the area.

[1] Accessible wells include those for which the landowner and/or the owner/operator of the water well would grant permission to Newfield to sample.

Long-term monitoring of groundwater quality would be conducted at available and accessible water wells in the MBPA. **Table E-5** and **Figure H-1** depict known water wells within the MBPA. If access to a sufficient number of wells with good spatial distribution proves infeasible, shallow monitoring wells may be drilled in some areas to monitor potential freshwater resources. Given the programmatic nature of the project, it is not possible to know at this time which water wells would be hydraulically down-gradient from individual gas production wells. During the permitting process for individual project elements, additional site-specific monitoring may be required following selection of specific drilling, or in response to conditions encountered during drilling activities.

There are no delineated freshwater aquifers within the MBPA; however, identification of shallow freshwater aquifers could occur during site-specific drilling. Additional monitoring points would be added to the monitoring network on a site-specific basis if freshwater aquifers are discovered during the drilling process. If a freshwater aquifer is encountered during drilling, a search of the nearby area would be conducted to determine if any springs or wells access the same aquifer. If so, these monitoring points would be investigated for accessibility, and permission would be sought to add them to the monitoring network.

Table E-5. Existing Long-term Shallow Groundwater Monitoring Locations

Name of Water Right Holder	Cadastral Location	Water Right Number and Type	Water Uses	Depth (feet)	Water Quality Data Available?
Newfield Production Company	T9S, R18E, Section 29	Well (47-1820)	Domestic, oil production	200–300	Yes
Inland Production Company	T8S, R17E, Section 21	Well (47-1805)	Unknown	4,990	No
Louis Clark Roberts	T8S, R17E, Section 21	Well (47-1346)	Unknown	Unknown	No

Clark and Arva Abegglen	T8S, R17E, Section 21	Well (47-1501)	Irrigation, Stock, Domestic	Unknown	No
USA Bureau of Land Management	T9S, R17E, Section 4	Well (47-1330)	Unknown	Unknown	No

At each groundwater monitoring location, field parameters would be measured, and a sample would be collected for analysis of the parameters listed in **Table E-6**. For all parameters, the detection limit for each individual analysis would be reported in the database. The inclusion of detection limits would allow for the accurate calculation of mean concentrations for parameters with large numbers of non-detect values; detection limits are required to be below applicable regulatory water quality standards or as specifically noted in **Table E-6**. Samples would be collected on a quarterly basis (one each in the winter, spring, summer, and fall) at each existing groundwater monitoring location, and any new groundwater monitoring location, over the LOP. Because baseline water quality data are limited, sample collection would include at least two rounds of baseline sampling prior to any drilling within the MBPA.

Table H-6. Parameters for Long-term Shallow Groundwater Monitoring

Field and General Water Quality Parameters	Trace Metals	Other Inorganic Constituents	Organic Constituents
Total Alkalinity	Aluminum	Ammonia	Volatile organic compounds (VOCs)[1]
Temperature	Barium	Arsenic	Semi-volatile organic compounds[2]
Specific Conductance	Cadmium	Bicarbonate	Radionuclides
pH	Calcium	Boron	Total petroleum hydrocarbons[3]
DO	Chromium	Carbonate	Methane and isotopes of methane[4]
DO saturation	Copper	Chloride	Full gas chemistry (ethane, propane, butane, pentane, etc.)[4]
Dissolved Hardness	Iron	Hydroxide	Hydrogen sulfide
TDS	Lead	Sulfate	Inorganic nitrogen
TSS	Manganese	–	Total phosphorus
Turbidity	Magnesium	–	Potassium
–	Mercury	–	Orthophosphate
–	Nickel	–	Kjeldahl-nitrogen
–	Selenium	–	Total organic carbon
–	Silver	–	–
–	Sodium	–	Chemical oxygen demand
–	Zinc	–	–

[1] VOCs would be analyzed using EPA Method 8260 or a fully equivalent standard method. Benzene would be analyzed at a detection limit of 1 microgram per liter or lower.

[2] Semi-volatile organic compounds would be analyzed using EPA Method 8270 or a fully equivalent standard method

[3] Total petroleum hydrocarbons would include at a minimum analysis for diesel-range organics and gas-range organics.

[4] Methane would be analyzed at a detection limit of 10 micrograms per liter or lower. If methane is detected above laboratory detection limits; isotopes of methane and full gas chemistry (e.g., methane, ethane, propane, butane, and pentane) would be analyzed.

Static groundwater levels would also be measured at the time of sample collection, prior to any pumping disturbance. Sampling techniques would be specified in the project-specific QAPP prior to data collection.

E.4 REPORTING OBLIGATIONS AND PLAN REVIEW

All water resources monitoring would be conducted under the supervision of a qualified hydrologist. Quarterly monitoring results would be entered into a database and summarized quarterly. Data and quarterly summaries would be delivered to the BLM Vernal Field Office, the UDWQ, and the UDOGM Roosevelt Office. In addition, the hydrologists who are responsible for monitoring activities will prepare an annual monitoring report. At a minimum, this report would contain a description of the monitoring results that identifies by location, observed trends in water quality, any identified potential impacts to water quality, flow conditions, changes in depth to groundwater, recommendations for changes in the long-term monitoring program, and recommendations for mitigation measures to reduce any impacts observed.

The BLM would review the monitoring plan every two years to determine 1) if the plan needs to be changed to adapt to data results; 2) the locations of active project construction; and 3) other project variables. However, these changes should meet the monitoring objectives described in **Section E.1** and defined in the project-specific QAPP. These changes could include relocation, addition, subtraction, or substitutions of monitoring locations or addition or subtraction of monitoring parameters, and an increase or decrease of monitoring frequency if evidence suggests that this is appropriate. All recommended changes, with an explanation for the requested change, would be submitted to the BLM and approved prior to implementation.

In addition to the annual reports, a cumulative assessment of the previous five years of monitoring results would be compiled every five years. A final report would also be completed at the conclusion of the project, which would summarize the entire monitoring program and include a final assessment of all sites monitored throughout the LOP. All monitoring reports would be submitted to the BLM, UDWQ, and UDOGM, and they would be made available to the public upon request.

E.4.1 Source Identification and Mitigation

Monitoring serves to identify the range, intensity, and effects of impacts directly or indirectly related to development. When and if a water resources concern is identified at an established monitoring point, BLM would work with Newfield (and potentially other operators in the area) to conduct an investigation that may include additional monitoring to identify the source of the problem. Water resources concerns associated with the proposed project would include any of the impacts described in **Section E.1**, including the presence of contaminants associated with oil and gas development, changes in water quality associated with surface disturbance, or changes in groundwater levels or stream flows. The QAPP would quantify monitoring "triggers" that would indicate the possible need for more intensive monitoring to identify the source (point or nonpoint) of the concern. At a minimum, these triggers would include drinking water quality standards, where applicable, and/or an established percentage above baseline data. If any of the parameters listed in **Tables E-2**, **E-4**, or **E-6** are found to be above established levels, the BLM, UDWQ, and UDOGM would be immediately notified, and source identification and mitigation measures would be considered by these agencies. The following are additional monitoring and/or mitigation measures that would be considered in the event of an identified impact:

- **Increased Sedimentation**
  - Review BMPs used for road, well pad, and pipeline construction to reduce sediment delivery to area streams.
  - Use additional sediment and erosion controls at well pads and along access roads.
  - Identify and increase treatment (paving, stabilizing, or surface treating) to critical portions of roads.
  - Relocate proposed well pads, roads, and/or pipelines to avoid erosion-prone areas.

- **Increased Concentrations of Inorganic Constituents, including Metals**
  - Review dust suppression program, including the types of chemical agents used, and modify if necessary.
  - Review BMPs used for road, well pad, and pipeline construction to reduce sediment delivery to area streams and increase implementation levels if necessary.
  - Use additional sediment and erosion controls at well pads and along access roads.
  - Identify and increase treatment (paving, stabilizing, or surface treating) to critical portions of roads.
  - Relocate proposed well pads, roads, and/or pipelines to avoid erosion-prone areas.
  - In cases of increased concentrations of selenium, boron, or TDS, collaborate with UDWQ to determine the source of the increase and whether oil and gas development has contributed to the increase. Implement appropriate BMPs to mitigate the identified source and/or pathway.

- **Contamination with Petroleum and other Organic Constituents**
  - Review the cementing program for well completion, including audits of cement bond records for wells near the impacted streams.
  - Conduct inspections of well pad facilities that may be leaking, including reserve pits, storage tanks, evaporation ponds, aboveground piping, and process units.
  - Require complete remediation of any observed spills or leaks encountered during the well inspections.
  - Review truck loading procedures for produced water and petroleum products.
  - Require compensation to the well owner/water user and disclose the contamination of the impacted well, spring, or surface water to the EPA, and Utah Department of Environmental Quality.
  - Identify and consider potential alternate sources of water (drill new well, haul water from offsite, etc.).

- **Reduction of Spring Flows**
  - Assess whether reduction in spring flow is seasonal fluctuation, due to drought, or the possible result of drilling activities.
  - Identify source area of spring using appropriate methods (e.g., tracer study), when feasible.

- Review the cementing program for well completion, including review of cement bond logs for wells drilled near the impacted springs.
- Collect all available historic records concerning pumping history and water levels in nearby water supply wells on spring flows. If feasible, implement continued measurements of pumping rates and water levels in water supply wells.
- Require compensation be made to users of impacted springs.
- Implement conservation or water re-use procedures to reduce withdrawals from water supply wells near, or hydrologically connected to impacted springs.
- Identify and consider potential, alternate sources of water (drill new well, haul water from offsite, etc.).

- **Reduction of Water Levels in Wells**
  - Identify whether the reduced water levels are substantial and affect the availability of water (i.e., below pump intake).
  - Review the cementing program for well completion, including review of cement bond logs for wells drilled near the impacted water sources.
  - Evaluate the effects of water supply wells on existing water sources.
  - Require that compensation be made to users of impacted wells.
  - Implement conservation or water re-use procedures to reduce withdrawals from water supply wells near, or hydrologically connected to impacted wells.
  - Identify and consider potential alternate sources of water (drill new well, haul water from offsite, etc.).

E.5 REFERENCES

U.S. Environmental Protection Agency (EPA). 2001. EPA Requirements for Quality Assurance Project Plans. Available at: http://www.epa.gov/quality/qs-docs/r5-final.pdf. Accessed May 15, 2011.

ATTACHMENT F Monument Butte Cactus Conservation Restoration and Mitigation Strategy

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Conservation, Restoration, and Mitigation Strategy for the Pariette and Uinta Basin Hoookless Cactus for the Newfield Greater Monument Butte Project

Attachment F contains the Conservation, Restoration, and Mitigation Strategy for the Pariette and Uinta Basin Hoookless Cactus for the Newfield Greater Monument Butte Project as developed by the FWS and Newfield. Two documents which were considered during the creation of this Strategy are also included in this Attachment as Appendices.

Attachment F Appendix 1 contains information that was derived from a Newfield-prepared power-point presentation that explains the anticipated benefit of various mitigation strategy components, focusing on their proposed dust reduction measures, which contributed to the creation of the Strategy.

Attachment F Appendix 2 contains a cactus survey report for the reclaimed Pariette Federal #16-28 well and road which was plugged, abandoned, and reclaimed in 1984. The report was prepared by Kleinfelder on November 7, 2014.

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Final Conservation and Mitigation Strategy For the Pariette Cactus and Uinta Basin Hookless Cactus, Newfield Greater Monument Butte Project

5/26/2015

Introduction

Pariette cactus (*Sclerocactus brevispinus*) and Uinta Basin hookless cactus (*Sclerocactus wetlandicus*) (collectively referred to as *Sclerocactus*) are listed as threatened species under authority of the Endangered Species Act (ESA). Threats include mineral and energy development, illegal collection, recreational off-road vehicle use, and grazing [U.S. Fish and Wildlife Service (USFWS) 2010]. The primary goal of the endangered species program under the ESA is recovery of the species. In order to reach this goal, threats to the survival must be reduced and the species must be a secure, self-sustaining part of its ecosystem. While project proponents are not be required to recover a species through project-specific authorizations by Bureau of Land Management (BLM), under the Section 7 consultation process, the USFWS works with the applicant and action agency to develop conservation measures that benefit the species. A net benefit to *Sclerocactus* can be achieved through the protection of the cactus and suitable habitat throughout the species' range, reduction of threats through minimization of ground surface impacts, mitigation of project impacts, and restoration of previously disturbed lands.

Newfield is proposing to construct 5,750 wells on 1,245 new well pads, and accompanying roads and pipelines on its valid existing leases within the Greater Monument Butte Federal Oil and Gas Unit authorized by BLM. In the USFWS's designated core conservation areas (CCAs) for *Sclerocactus* and the *Sclerocactus* habitat polygon, Newfield is committed to avoiding direct impacts to *Sclerocactus* individuals when siting new well pads, well pad expansions, pipelines, access roads, and the installation of product flow lines that significantly reduce the impacts of truck traffic and associated dust impacts. Newfield commits to the *Sclerocactus* specific applicant committed conservation measures outlined in the USFWS Recommended Conservation Measures for *Sclerocactus*: Uinta Basin hookless cactus (*Sclerocactus wetlandicus*) and Pariette cactus (*Sclerocactus brevispinus*), 2014 (Appendix A). This includes a commitment to conduct surface disturbing activity outside of the *Sclerocactus* flowering period (March 15-August 30) for all work proposed within Level 1 CCAs and within 300 feet (ft) of *Sclerocactus* in Level 2 CCAs and the *Sclerocactus* Habitat Polygon. However, there are additional remaining potential impacts to *Sclerocactus* from Newfield's proposed action, including habitat disturbance and potential indirect impacts to the species from the remaining effects of dust.

This strategy has been devised to avoid, minimize, and mitigate for *Sclerocactus* throughout the Newfield Greater Monument Butte project area, while also being consistent with Newfield's valid existing lease rights, federal unit obligations, and proposed development, as well as BLM's legal authority and jurisdiction. The strategy is designed to allow the use of successful mitigation to offset Newfield's proposed new surface disturbance in Level 1 CCAs, surface disturbance above 5 percent or within 300 ft of *Sclerocactus* in Level 2 CCAs, and surface disturbance within 300 ft of *Sclerocactus* within the *Sclerocactus* Habitat Polygon.

Sclerocactus Habitat Mitigation

Tables 1 and 2 represent potential mitigation measures that may be completed in order to offset impacts associated with the Newfield Greater Monument Butte Project. Table 1 identifies mitigation options, and Table 2 explains the amount of mitigation needed per acre of new surface disturbance. Descriptive text follows the tables.

Table 1. Mitigation options to offset impacts to *Sclerocactus* habitat.

Requested Disturbance	Conservation Easement/NSO	Habitat Restoration, *Sclerocactus* Survival, Recruitment	Reduction in Truck Traffic	Mitigation Fund
CCA 1: 8 New Well Pads	✓	✓		
CCA 1: Well Pad Expansion	✓	✓	✓	✓
CCA 2: Current disturbance >5% and < 25%	✓	✓	✓	✓
CCA 2: Current disturbance < 5% and *Sclerocactus* within 300 ft	✓	✓	✓	✓
Sclerocactus Habitat Polygon: Disturbance within 300 ft of *Sclerocactus*	✓	✓	✓	✓

Table 2. Mitigation Ratios (mitigated acres:disturbance acres)

Disturbance Location	Disturbance Type	Mitigation Method								
		Conservation Easement/NSO		Restoration of Entire Facilities[1] (full well pads, roads, and pipelines)			Restoration Facility Edges[1]	Truck Traffic Reduction		Mitigation Fund (Appendix B)
		High Cactus Densities (A.1)	Moderate Cactus Densities (A.2)	Habitat Restoration	+Cactus Survival	+Cactus Recruitment		CCA 1	CCA 2	
CCA 1	8 new well pads	3:1	—	5:1	3:1	2:1	—	—	—	—
	Well pad expansion	3:1	—	5:1	3:1	2:1	—	20:1	—	$7,510/acre
Occupied habitat in CCA 2 or *Sclerocactus* Habitat Polygon[2]	All	1:1	2:1	4:1	3:1	2:1	4:1	5:1	10:1	$6,260/acre (CCA2) or $2,550/acre (Habitat Polygon)
Unoccupied habitat where CCA 2 >5% Disturbance[2,3]	All	1:1	2:1	1:1	1:2	1:3	4:1	5:1	10:1	$6,260/acre

[1] Restoration must occur in equal or greater quality habitat compared to the location of the new disturbance; e.g., restoration as mitigation for impacts to CCA2 must occur in CCA2 or CCA1 polygons.

[2] Occupied is defined as habitat < 300 ft from *Sclerocactus* individuals. Unoccupied is defined as habitat > 300 ft from *Sclerocactus* individuals.

[3] Mitigation is not required in unoccupied habitat where CCA2 <5% disturbance, or in unoccupied habitats of the *Sclerocactus* Habitat Polygon.

A. Establishment of Conservation Easements or Voluntary No Surface Occupancy in Occupied Habitat

Conservation easements or voluntary No Surface Occupancy (NSO) areas can be used to offset impacts in:

- Level 1 CCAs from 8 new well pads not to exceed 20 acres, or well pad expansion not to exceed limits analyzed in the Environmental Impact Statement (EIS),
- Level 2 CCAs that have current cumulative disturbance between 5 and 25 percent,
- Level 2 CCAs when disturbance is < 5 percent and within 300 ft of *Sclerocactus* *Sclerocactus* Habitat Polygon when disturbance is within 300 ft of *Sclerocactus*

The following *Sclerocactus* density criteria must be met for new conservation easements or NSO areas, unless otherwise approved by the USFWS:

A.1. Level 1 CCAs:

To offset new disturbance impacts in Level 1 CCAs, conservation easement or NSO areas must be occupied by *Sclerocactus* at a rate of at least 25 *Sclerocactus* per 40 acres, unless otherwise approved by the Service. *Sclerocactus* density rates would be determined by a USFWS qualified botanist;

A.2. Level 2 CCAs and *Habitat Polygon:*

To offset new disturbance impacts in Level 2 CCAs (above 5 percent per Level 2 CCA unit (occupied or unoccupied); Level 2 CCAs < 5 percent and within 300 ft of *Sclerocactus*; or the *Sclerocactus* Habitat Polygon, the establishment of conservation easements or NSO must be occupied by *Sclerocactus* at a rate of at least 15 *Sclerocactus* per 40 acres, unless otherwise approved by the USFWS.

In addition, new conservation easements or NSOs must meet the following criteria:

1. Parcel quality and size:
    a. At least 50 percent of the parcel is suitable habitat for *Sclerocactus*;
    b. The parcel is within the current range of *Sclerocactus*;
    c. The parcel has less than 5 percent existing surface disturbance;
    d. The parcel is a minimum of 40 acres;
    e. The surface of the conservation easement or NSO area is closed to future surface disturbing activities. Surface disturbing activities include but are not limited to new blading and leveling on ground surface, plowing, disking, harrowing, and any other activities that negatively affect habitat conditions or population stability; and
2. The conservation easement or NSO must be finalized and recorded prior to new disturbance.
3. Should the proposed easement or NSO parcel meet the criteria defined above, a proposal will be prepared by Newfield and submitted to the USFWS. Upon receipt, the USFWS will have 60 days to review and approve the conservation easement or NSO area.

4. The conservation easement or NSO shall be recorded with the property in perpetuity, or identified in the BLM land use plan as an NSO for the conservation and recovery of the *Sclerocactus*. The use of conservation easements or NSOs for mitigation will need to be approved by the USFWS on a site-specific basis. For BLM NSOs, USFWS approval will be in part dependent on the ability of BLM to: 1) reach an agreement for NSOs with lease holders, 2) ensure the long-term protection of the mitigation area by showing the intent to maintain the NSO designation in future land use plans, and 3) agree to discuss any future NSO changes and resultant additional conservation measures with USFWS.
5. The USFWS will be allowed access to the conservation easement to monitor the *Sclerocactus* and its habitat.
6. The purpose of the conservation easement or NSO area is to: (1) preserve the property in its existing, comparable, or better condition as suitable habitat for *Sclerocactus*; (2) preserve and protect the conservation values of the property; and (3) prevent any use of the property that will impair or interfere with *Sclerocactus*, its habitat, or other conservation values of the property.
7. Conservation Easement/NSO Monitoring and Management: Newfield will conduct a baseline assessment and mapping of the *Sclerocactus* population and assessment of habitat quality on conservation easement and NSO lands. Funding for future monitoring and management of NSOs on BLM land will be determined through coordination between Newfield and BLM.

   In the event that Newfield purchases private property and places a conservation easement on that property for the protection of *Sclerocactus* and/or its habitat, any future monitoring and management shall be contracted for and funded with Newfield's contributions to the *Sclerocactus* Mitigation Fund for this Greater Monument Butte Project.

   In the event that Newfield purchases a conservation easement through a third party private property owner for the protection of *Sclerocactus* and/or its habitat, then Newfield, USFWS, and the private property owner shall determine whether additional funds or other financial assurances to cover the costs of monitoring and any maintenance actions are deemed necessary. In the event such assurances are needed, then Newfield, USFWS, and the private property owner shall determine what mechanism will be most suitable at that time. Financial assurance for easements could be a one-time payment made by Newfield to an endowment which then would then bear interest to cover the monitoring and management costs. Financial assurances may also be similar one-time payments in the form of performance bonds, escrow accounts, insurance, collateral assignment of a certificate of deposit, certified or cashier's check, letter of deposit, or other approved instrument. Such assurances may be phased-out or reduced once it has been demonstrated that the easement is of low risk.

<u>*Conservation Easement or Voluntary NSO Exchange Ratios:*</u>

a. A 3:1 ratio (3 acres of conservation easement or NSO per 1 acre of new disturbance) will be implemented for Level 1 CCA disturbance if a conservation easement or NSO parcel is acquired according to the criteria as listed above (section A.1). No more than 20 acres of new well pads (associated with Newfield's proposed 8 new well pads) will be permitted in Level 1 CCAs. Disturbance acres for well pad expansions will not exceed the limit analyzed in the EIS.

b. A 1:1 ratio (1 acre of conservation easement or NSO per 1 acre of new disturbance) will be implemented for disturbance in Level 2 CCA and the *Sclerocactus* Habitat Polygon, if a conservation easement or NSO parcel is acquired according to the criteria as listed above (section A.1). All disturbances must be within the analyzed limit addressed in the EIS. This ratio will be used to offset impacts in Level 2 CCAs where new disturbance is within 300 ft of *Sclerocactus* or above the 5 percent disturbance threshold. This ratio will also be used to offset impacts where disturbance is within 300' of *Sclerocactus* within the *Sclerocactus* Habitat Polygon.

c. A 2:1 ratio (2 acres of conservation easement or NSO per 1 acre of new disturbance) will be implemented for disturbance in Level 2 CCA and *Sclerocactus* Habitat Polygon if a conservation easement or NSO parcel is acquired according to the criteria as listed above (section A.2). All disturbances must be within the analyzed limit addressed in the EIS. This ratio will be used to offset impacts in Level 2 CCAs where new disturbance is within 300 ft of *Sclerocactus* or above 5 percent disturbance threshold within Level 2 CCAs. This ratio will also be used to offset impacts where disturbance is within 300 ft of *Sclerocactus* within the *Sclerocactus* Habitat Polygon.

B. Sclerocactus Habitat Restoration, Sclerocactus Survival, and Sclerocactus Recruitment

There are opportunities in CCAs to reduce the existing surface disturbance of old well pads, roads, and cross-country pipeline rights-of-way, thereby restoring *Sclerocactus* habitat conditions and reducing fragmentation.

The applicant will use USFWS Mitigation Guidelines (USFWS 2014; Appendix B) and subsequent versions (as current information on arid lands restoration and *Sclerocactus* recovery evolves) to restore disturbed areas. Restoration includes additional measures beyond those used by the BLM in their reclamation guidelines. Topsoil development in arid lands is an extremely slow process. Once topsoil is removed, amendments may be necessary to provide the appropriate organic and inorganic soil constituents needed to support the biological community (Eldridge et al. 2012). The applicant will use the BLM Green River District Reclamation Guidelines and subsequent versions to reclaim disturbed areas. BLM reclamation guidelines require recontouring sites and reseeding them with native species. All areas will be reclaimed and restored and the applicant cannot re-disturb the restoration sites unless additional compensation (taking into account the prior loss of *Sclerocactus* habitats) fully offsets the loss.

Successful habitat restoration, survival, and recruitment (see Table 2) can be used to offset impacts in:

- Level 1 CCAs for new surface disturbance from the 8 new well pads.
- Level 1 CCAs for new surface disturbance from well pad expansion.
- Level 2 CCAs where cumulative disturbance level is between 5 and 25 percent for new surface disturbance.
  Level 2 CCAs that are below 5 percent cumulative disturbance for new surface disturbance that is within 300 ft of *Sclerocactus*.

- *Sclerocactus* Habitat Polygon for new surface disturbance where new disturbance is within 300 ft of *Sclerocactus*.

Restoration Standard

Restoration of Habitat shall be deemed sufficient if it meets the following criteria:

1. Reclamation meets the BLMs Green River District Reclamation Guidelines;
2. Restoration meets the 2014 Restoration Mitigation Guidelines (Appendix B); and
3. *Sclerocactus* are outplanted into the habitat via seed or starts from a Service approved authorized source and by a USFWS approved authorized individual that has been hired by Newfield.
4. If *Sclerocactus* do not survive within the first 5 years post outplanting, Newfield will consult with USFWS and outplant *Sclerocactus* a second time in order to achieve the Survival Standard. Only one additional outplanting is required (if the initial planting is not successful) after the initial *Sclerocactus* outplanting. After the initial outplanting, no *Sclercactus* monitoring is required past 5 years, regardless if a second outplanting is conducted.

Survival Standard

Survival of *Sclerocactus* shall be deemed sufficient if it meets the following criteria:

1. Within Level 1 CCAs an average of 8 or more *Sclerocactus* per acre are documented in the restored area after 5 years of monitoring, as verified by a botanist acceptable to the Service.
2. Within Level 2 CCAs an average of 4 or more *Sclerocactus* per acre rate are documented in the restored area after 5 years of monitoring, as verified by a botanist acceptable to the USFWS.

Recruitment Standard

Recruitment of *Sclerocactus* shall be deemed sufficient if it meets the following criteria:

New seedlings germinate within *Sclerocactus* habitat and survive to the juvenile life stage (approximately 2.5-4 cm).

Documentation and Monitoring

1. Documentation and Monitoring reports for restoration of habitat that will be sent to the USFWS on an annual basis shall include:
   a. A report detailing number *Sclerocactus* individuals outplanted on reclaimed and restored habitat each year, the source of the propagated *Sclerocactus*, restoration company qualifications, GIS location of the outplanted *Sclerocactus*, and all methods used in the propagation and outplanting.
   b. Third Year after Outplanting – report detailing the survival rate of the *Sclerocactus*, health (may be measured by size, color, or damage), recruitment, and reproduction, including photo documentation and field notes.

c. Fifth Year after Outplanting – report detailing the survival rate of the *Sclerocactus*, health (may be measured by size, color, or damage), recruitment, and reproduction, including photo documentation and field notes.

Restoration, Sclerocactus Survival, and Sclerocactus Recruitment Ratios

Table 2 lists ratios associated with restoration, survival, and recruitment.

Bond

If Newfield would like to start oil and gas development work before achieving successful habitat restoration, they will implement restoration and they will contribute to a bond. The bond price will be based upon the cost of restoration work plus an additional 25 percent to cover inflation and future increases in restoration costs. The total bond price will be $9,388 ($7,510 plus 25 percent) per acre of new disturbance within Level 1 CCA. The total bond price will be $7,825 ($6,260 plus 25 percent) per acre of new surface disturbance within: (1) Level 2 CCAs above 5 percent disturbance, but below 25 percent disturbance; or (2) Level 2 CCAs < 5 percent disturbance and within 300 ft of *Sclerocactus*. The total bond price will be $3,188 ($2,550 plus 25 percent) per acre of new surface disturbance within 300 ft of *Sclerocactus* in the *Sclerocactus* Habitat Polygon.

If the applicant does not choose to secure a bond, they will be responsible for successful habitat restoration (*Sclerocactus* propagation, outplanting, survival, and recruitment after 5 years of monitoring) prior to new surface disturbance: for Level 1 CCA, above 5 percent cumulative disturbance within Level 2 CCAs, < 5 percent and within 300 ft of *Sclerocactus* in Level 2 CCAs, and within 300 ft of *Sclerocactus* in the *Sclerocactus* Habitat Polygon.

Bond Release

The bond will be released after:

- Newfield has implemented complete restoration actions that meet the Restoration Standard (above).

C. Reduction of Dust Impacts

Reduction of dust impacts can be used to offset impacts in:

- Level 1 CCAs for well pad expansions
- Level 2 CCAs and the *Sclerocactus* Habitat Polygon.

Removal of oil and gas production facilities and equipment and replacement with pipeline conveyance systems will result in significant truck traffic reduction, which in turn reduces dust and related indirect impacts on listed plant species. For example, according to Newfield production data, approximately 340 tanker trucks travel to existing facilities in Level 1 CCAs each month. This volume is projected to increase between 500 to 700 tanker trucks per month between 2015 and 2018, and during maximum production, truck traffic could increase to over

3,000 tanker trucks per month. If produced oil and gas can be conveyed with flow lines and offsite tank batteries, all tanker truck traffic to producing well pads will be eliminated. Traffic will then be limited to operational, safety, and environmental compliance inspections which are conducted every other day by pick-up truck, as well as periodic work-overs and their associated traffic. By installing flow lines and offsite tank batteries, it is estimated that total traffic will be reduced by 95 percent from current volumes, and this percentage will increase over time.

According to Newfield, a total of 131.2 acres of roads in Level 1 CCAs and 298.6 acres of roads in Level 2 CCAs will be affected by this 95 percent reduction of tanker truck traffic if the flow line installation occurs. Road acreage is calculated by the acres of road width disturbance. The following mitigation ratios provide an exchange of dust abatement efforts for corresponding well pad expansions in Level 1 CCAs and new disturbance less than 5 percent in Level 2 CCAs.

1. Reduction of Truck Traffic and Dust Ratio
    a. For every 20 acres of roads that have reduced truck traffic by 95 percent within Level 1 CCAs, a well pad can be expanded by 1 acre within Level 1 CCAs.
    b. For every 5 acres of roads that have reduced truck traffic by 95 percent within Level 1 CCAs, Newfield could disturb 1 additional acre within Level 2 CCAs or the *Sclerocactus* Habitat Polygon.
    c. For every 10 acres of roads that have 95 percent reduced truck traffic within Level 2 CCAs, Newfield could disturb 1 acre of terrain within Level 2 CCAs or the *Sclerocactus* Habitat Polygon.

D. *Sclerocactus* Mitigation Fund

Sclerocactus Mitigation Fund and guidelines for restoration are included in Appendix B.

Literature Cited

Eldridge, J.D., E. F. Redente, and M. Paschke. 2012. The Use of Seedbed Modifications and Wood Chips to Accelerate Restoration of Well Pad Sites in Western Colorado, U.S.A. Restoration Ecology 4:524-531.

USFWS. 2010. Recovery Outline for the Sclerocactus *wetlandicus*. Utah Ecological Services Field Office, Salt Lake City, Utah.

USFWS. 2014. 2014 Ecological restoration mitigation calculation guidelines for impacts to Sclerocactus *wetlandicus* and Sclerocactus *brevispinus* habitat. Utah Ecological Services Field Office, Salt Lake City, Utah.

Appendix A

U.S. Fish and Wildlife Service Recommended Conservation Measures for *Sclerocactus*: Uinta Basin hookless cactus (*Sclerocactus wetlandicus*) Pariette cactus (*Sclerocactus brevispinus*) March 11, 2014

Conservation measures are actions that the action agency and applicant agree to implement to further species recovery. The beneficial effects of conservation measures are taken into consideration for determining the overall project impacts to species. The following list of conservation measures for Uinta Basin hookless cactus (*Sclerocactus wetlandicus*) and/or Pariette cactus (*Sclerocactus brevispinus*) (collectively referred to as *Sclerocactus*) will help minimize the impacts of a proposed action to these threatened species.

SCLEROCACTUS SURVEYS

- Pre-project habitat assessments will be completed across 100 percent of the project disturbance area within potential habitat prior to any ground disturbing activities to determine if suitable *Sclerocactus* habitat is present.

- Pre-construction *Sclerocactus* surveys will occur following the pre-project habitat assessments that identified any suitable habitat within the project area. These pre-construction surveys must follow U.S. Fish and Wildlife Service (USFWS) Utah Field Office Guidelines for Conducting and Reporting Botanical Inventories and Monitoring of Federally Listed, Proposed, and Candidate Plants. Surveys will be conducted in suitable habitat prior to initiation of project activities, at a time when the plant can be detected, and during appropriate flowering periods:

    - *Sclerocactus brevispinus* surveys must be conducted between March 15th and June 30th, unless an extension is provided in writing by the USFWS
    - *Sclerocactus wetlandicus* surveys can be done any time of the year, provided there is no snow cover.

- *Sclerocactus* surveys will be conducted by a qualified botanist. Qualifications are defined in the USFWS Utah Field Office Guidelines for Conducting and Reporting Botanical Inventories and Monitoring of Federally Listed, Proposed and Candidate Plants, http://www.fws.gov/utahfieldoffice/SurveyorInfo.html. Qualified botanists must also attend the USFWS Uinta Basin Rare Plant Workshop, http://www.fws.gov/utahfieldoffice/UBRarePlants.html.

- Surveys will be valid for one year from the survey date for *Sclerocactus brevispinus* and *Sclerocactus wetlandicus.*

- *Sclerocactus* spot check surveys will be conducted on an annual basis by a qualified botanist, and reviewed by the Bureau of Land Management (BLM) and our office for all planned disturbance areas if the project has not been completed within the year following pre-construction plant surveys. Review of spot checks may result in additional pre-construction plant surveys as directed the BLM and our office. If the proposed action has not occurred within four years of the original survey, additional coordination with the BLM and our office must occur and a new clearance survey may be necessary prior to ground disturbing activities.

- *Sclerocactus* surveys for access roads, buried pipelines, well pads, and other facilities requiring removal of vegetation (e.g., compressor stations) will include the project area and/or right-of-way (ROW), and 300 feet (ft) from the edges of the project disturbance and/or ROW.

- *Sclerocactus* surveys for surface pipelines placed within an existing road ROW, and within 10 ft from the edge of the disturbed surface of the road, will include the ROW and 50 ft from the edge of the ROW on the pipeline side of the road.

- *Sclerocactus* surveys for cross-country surface pipelines (pipelines over 10 ft from a road), where the pipeline will be laid by hand with minimal disturbance and no vehicle use will include the ROW and 50 ft from the edges of both sides of the ROW.

- Surveys for all other cross-country surface pipelines (vehicles or equipment used, not laid out by hand) will include the ROW and 300 ft from the edges of both sides of the ROW.

- *Sclerocactus* surveys will not be necessary when pipelines are buried in existing roads.

PROJECTS PROPOSED WITHIN *SCLEROCACTUS* HABITAT

General Measures

- Ground disturbing activities in Level 1 CCAs and within 300 ft of individual *Sclerocactus* plants and/or populations must occur outside of the flowering period, April 1 - May 30.

- Access roads, buried pipelines, well pads, and other facilities requiring removal of vegetation (e.g., compressor stations) will be located a minimum distance of 300 ft from individual *Sclerocactus* plants and/or populations where feasible (and in accordance with Level 1 and 2 CCA conservation recommendations, as outlined below).

- Surface pipelines will be located at a minimum of 50 feet from individual *Sclerocactus* plants and/or populations where feasible (and in accordance with Level 1 and 2 CCA conservation recommendations, as outlined below).

- New surface pipelines located closer than 50 feet to known *Sclerocactus* individuals will be secured in place to prevent pipeline movement (and in accordance with Level 1 and 2 CCA conservation recommendations, as outlined below).
- Only water and methods approved by the BLM (no chemicals, reclaimed production water or oil field brine) will be used for dust abatement measures within *Sclerocactus* habitat.

- Dust abatement will be employed in suitable *Sclerocactus* habitat over the life of the project during the time of the year when *Sclerocactus* species are most vulnerable to dust-related impacts (March through August).

- Noxious weeds within *Sclerocactus* habitat may be controlled with herbicides, in accordance with the BLM Herbicide PEIS (http://www.blm.gov/wo/st/en/prog/more/veg_eis.html). Guidelines and the BLM’s Standard Operating Procedures for Threatened and Endangered Plant Species (Table 1).

- Application for a Pesticide Use Permit will include provisions for mechanical removal, as opposed to chemical removal, for Utah Class A, B, and C noxious weeds within 50 feet of individual/populations of *Sclerocactus*.

- Erosion control measures (e.g., silt fencing) will be implemented to minimize sedimentation to *Sclerocactus* plants and populations located down slope of proposed surface disturbance activities, and should only be implemented within the area proposed for disturbance.

- All disturbed areas will be reclaimed with plant species native to Utah, or seed mixtures approved by the BLM and our office, which may include the use of sterile, non-native, non-invasive, annuals to help secure topsoil and encourage native perennials to establish.

Level 1 CCAs:

- Avoid new surface disturbance, including well pads, roads, pipelines, or any other surface disturbing activities where feasible. Expansion of existing facilities will be allowed—e.g., widening existing access roads, expanding well pads, installation of pipelines to access existing facilities (along existing alignments or roadways).

- Where access roads are widened, well pads are expanded, or buried pipelines access existing facilities, design projects to minimize impacts by:

  - Locating project a minimum distance of 300 ft from individual *Sclerocactus* plants and/or populations (except for surface pipelines which is 50 ft),
  - Utilizing existing well pads and infrastructure,
  - Using common ROWs for roads and utilities where possible, and
  - Placing signing to limit off-road travel in sensitive areas.

- Where new surface disturbance occurs within the Level 1 CCAs, mitigation must be completed following the Conservation and Mitigation Strategy For the Pariette Cactus and Uinta Basin Hookless Cactus, Newfield Greater Monument Butte Project (Strategy).
- Where new surface disturbance directly affects *Sclerocactus* (*Sclerocactus* are directly removed), a monetary amount ($640 per *Sclerocactus*) will be contributed to the *Sclerocactus* Mitigation Fund-BLM to aid in the recovery of *Sclerocactus* species impacted by the project. These contributions are in addition to payments requested for indirect effects to *Sclerocactus*. Contributions will be negotiated between the Operator and the our office in consultation and will be based on the number of *Sclerocactus* directly impacted and in relation to our office's current management guidelines for *Sclerocactus*.

- Several options for mitigation of Level 1 CCAs are present (see Strategy). If mitigation funds are established, funds will be paid to:

  Sclerocactus Mitigation Fund – BLM
  Michelle Olson, Manager

Impact-Directed Environmental Accounts National Fish and Wildlife Foundation
Fifteenth Street NW, Suite 1100 Washington, DC 20005

Level 2 CCAs:

- New surface disturbance, including well pads, roads, pipelines, or any other surface disturbing activities will not exceed a 5 percent surface disturbance threshold where feasible.

- If the total cumulative surface disturbance is below the 5 percent threshold, and where access roads, buried pipelines, well pads, or other facilities requiring removal of vegetation (e.g., compressor stations) will be constructed, design project to minimize impacts by:

    - Locating project a minimum distance of 300 ft from individual *Sclerocactus* plants and/or populations (except for surface pipelines which is 50 ft).

- If the total cumulative surface disturbance is above the 5 percent threshold, and/or where new surface disturbance indirectly affects *Sclerocactus* (*Sclerocactus* within 300 ft of proposed disturbance), mitigation will occur following the Strategy.

- Where new surface disturbance directly affects *Sclerocactus* (*Sclerocactus* are directly removed), a monetary amount ($640 per cactus) will be contributed to the *Sclerocactus* Mitigation Fund-BLM to aid in the recovery of *Sclerocactus* species impacted by the project. These contributions are in addition to payments requested for indirect effects to cacti (see previous measure). Contributions will be negotiated between the Operator and our office based on the number of *Sclerocactus* directly impacted and in relation to the our current management guidelines for *Sclerocactus*.

- Several options for mitigation of Level 2 CCAs are available (see Strategy). If mitigation funds are established, funds will be paid to:

  Sclerocactus Mitigation Fund – BLM
  Michelle Olson, Manager
  Impact-Directed Environmental Accounts National Fish and Wildlife Foundation 1133
  Fifteenth Street NW, Suite 1100
  Washington, DC 20005

Sclerocactus Habitat Polygon:

- Where access roads, buried pipelines, well pads, or other facilities requiring removal of vegetation (e.g., compressor stations) will be constructed, design project to minimize impacts by:

    - Locating project a minimum distance of 300 ft from individual *Sclerocactus* plants and/or populations (except for surface pipelines, which is 50 ft).

- Where new surface disturbance indirectly affects *Sclerocactus* (Sclerocactus within 300 ft of proposed disturbance), mitigation will occur following the Strategy.

- Where new surface disturbance directly affects *Sclerocactus* (*Sclerocactus* are directly removed), a monetary amount ($640 per *Sclerocactus*) will be contributed to the *Sclerocactus* Mitigation Fund- BLM to aid in the recovery of *Sclerocactus* species impacted by the project. These contributions are in addition to payments requested for indirect effects to cacti (see previous measure). Contributions will be negotiated between the Operator and our office based on the number of *Sclerocactus* directly impacted and in relation to our current management guidelines for *Sclerocactus*.

- Several options for mitigation of the *Sclerocactus* Habitat Polygon are available (see Strategy). If mitigation funds are established, funds will be paid to:

  Sclerocactus Mitigation Fund – BLM
  Impact-Directed Environmental Accounts National Fish and Wildlife Foundation 1133
  Fifteenth Street NW, Suite 1100
  Washington, DC 20005

Appendix B

2014 Ecological Restoration Mitigation Calculation Guidelines for impacts to *Sclerocactus wetlandicus* and *Sclerocactus brevispinus* Habitat

U.S. Fish and Wildlife Service, Utah Ecological Services Field Office
December 2014

Background:

The State of Utah ranks as the 10th and 11th largest producers nationally for gas and oil, and the majority of the state's production is centered in the Uinta Basin (Vanden Berg 2014). Total producing and active oil and gas wells in the Uinta Basin number more than 13,000, on 9,197 well pads (BLM 2012), with surface disturbance totaling more than 45,000 acres (assumes average of 5 acres of disturbance per well pad). Bureau of Land Management (BLM) analysis of 2011 data on pending NEPA projects forecasts more than 70,000 acres of additional oil and gas construction related disturbance in the next 15-20 years (BLM 2012). Current and projected energy development in the Uinta Basin overlaps with more than 90 percent of the range of the threatened Pariette cactus and Uinta Basin hookless cactus.

In 2012 we developed landscape scale conservation guidelines for the threatened Pariette cactus and Uinta Basin hookless cactus. The guidelines were developed to conserve and recover the species and prevent further habitat loss and fragmentation from energy development. Our strategy involved establishing core conservation areas (CCAs) that included dense aggregations of the threatened cactus species along with disturbance limits and pollinator buffers that allow for continued connectivity among these aggregations. The protection of pollinators and their habitat is important because these species depend primarily on pollination to produce seed. In order to further manage recovery of these cactus species across the landscape, our CCAs are grouped geographically into 8 Conservation Units in order to ensure genetic and ecological representation over the range of the species.

Level 1 CCAs include the densest aggregations of known cactus locations and were delineated based on a 400 m buffer around known plant locations (the buffer distance is based on foraging distances of primary pollinators; Tepedino 2010). Within these Level 1 CCAs our goal is to have no new surface disturbance; well pad and road expansion may be considered, but only after avoidance and minimization efforts along with appropriate compensatory mitigation. Level 2 CCAs are adjacent to Level 1 CCAs and include less dense aggregations of cactus, but are still considered important for overall population and habitat connectivity in the Uinta Basin. Level 2 CCAs were developed using a 1,000 m buffer around plants to allow for genetic connectivity and pollinator travel between Level 1 CCAs, and to provide additional habitat for cactus expansion and recruitment (Service 2012). Our goal is to maintain no more than 5 percent total surface disturbance within these Level 2 CCAs (Service 2012). Disturbance over 5 percent in Level 2 CCAs can occur once ecological restoration of disturbed habitat is completed so that disturbance stays at or below 5 percent. We recognize that some of the Level 2 CCAs are already above 5 percent surface disturbance. For these areas, we recommend that any disturbance above 5 percent in Level 2 CCAs be reclaimed to keep total disturbance at or below 5 percent and cumulative disturbance including areas that are reclaimed stay below 25 percent (Service 2012).

Reclamation of arid lands is difficult and full ecological restoration within the habitat of listed cactus species in Utah has not been successful (Grossl et al. 2012). We define full ecological restoration as supporting appropriate native community components and structure, returning land to a state with moderate to high ecological function that can support most processes and components of the pre-disturbance natural community, integrating into the surrounding landscape, resilient to environmental stressors, similar to a reference ecosystem (Society for Ecological Restoration (SER) 2004) and especially supporting listed plants and their habitat. Avoidance and minimization of impacts to listed species and their habitat is the first step in offsetting impacts.

Where impacts to listed plants and their habitats cannot be avoided or minimized we will consider ecological restoration as mitigation to offset these impacts. However, because we are currently unable to ensure successful ecological restoration, initial efforts will focus on researching restoration methods that may lead to improved techniques. As methods and inputs improve the estimated costs for restoration may change correspondingly. We have based the following 2014 mitigation costs on available information of the components needed for ecological restoration.

Ecological Restoration Components and Costs:

The following components are needed for ecological restoration of oil and gas impacts in the Uinta Basin:

1. *Treatment of non-native and invasive plants for 2 years.* Treatment and control of non-native plants is vital to reducing competition prior to establishing native plants (Sieg et al. 2003). Non-native and invasive plants increase dramatically in response to soil disturbance so treatment needs to be conducted before and after grading and re-

contouring of well pads, roads and other disturbed areas (Sieg et al. 2003). These activities are required by BLM's Green River Reclamation Guidelines (see Objective 6; Attachment 1 *in* BLM 2011) so although we recognize that this activity is an important component of restoration we are not including them in our mitigation costs as long as they are implemented as part of BLM's requirements. Where these measures are not required as part of BLM reclamation requirements, these costs will apply in our mitigation calculation. Cost estimates were determined at \$0.02- \$0.03 per ft^2 (Musich Custom Spraying, Oct 29, 2014, personal communication) for a cost of \$1,307 per acre.

2. *Grading and plowing of disturbed site (well pad, road).* Well pads, roads and other disturbed sites result in soil loss and compaction (Buto et al. 2010). In addition, many sites are leveled so that the topography no longer matches the surrounding area thus leading to wind and water erosion, disruption of weathering processes, water path, sedimentation, barriers to species movement (Service 2010). Re-contouring disturbed sites to match surrounding topography integrates the restored area into the larger landscape and reduces negative impacts to ecological communities. Subsequent plowing is necessary to ensure a favorable recipient site prior to planting native seed or plants.

   Re-contouring of disturbed sites is required by the BLM Green River District's Reclamation Guidelines (see Objective 2 and 3: Attachment 1 *in* BLM 2011). Where these measures are not required as part of BLM reclamation requirements, these costs will apply in our mitigation calculation.

   Plowing of the site or similar soil improvement immediately prior to seeding is not required by BLM so we have incorporated it into our costs. We estimate that plowing costs will be \$500 per acre given that heavy equipment will be needed to loosen soil in preparation for direct seeding and to provide necessary aeration and sufficient drainage for *Sclerocactus* species (J&L Oilfield Service Inc., Josh Justice, Oct 2, 2014, personal communication) and the low end cost for leveling well pads (~4 acres) is estimated at \$2,000 per acre but average costs are \$6,025 per acre (or \$24,100 per well pad) which is the cost we are using for the mitigation calculation.

3. *Soil amendments including cobble, topsoil, char, wood chips, biological soil crust inoculant or other nutrients/minerals.* Restoring soils in arid lands is an important component for restoring and supporting native plant communities. Topsoil development in arid lands is an extremely slow process so once topsoil is removed amendments may be necessary to provide the appropriate organic and inorganic soil constituents needed support the biological community. (Whisenant 1995; Eldridge et al. 2012). In addition, we know that biological soil crusts are an important component of these arid ecosystesms so restoration will include re-establishment of biological soil crusts (Rosentreter and Belnap 2001; Bowker et al. 2005). This is an ongoing area of restoration ecology and we will likely learn more through experimentation and analysis. Current cost estimates for soil amendment were estimated to range from \$1,200 to \$6,000 per acre (Schneider 2014, Western States Reclamation, Inc,), and adding local topsoil would cost \$300 per dump truck load (12 yards which covers 3,600 ft^2 at 1 inch depth) (All Red Paving, KW Trucking, Tri-County Concrete, Oct 2014, personal communication). Eleven truck loads

are needed to cover one acre with one inch of soil amendment, costing $3,300 per acre. We are using the $3,300 per acre cost for our mitigation estimates.

4. *Collecting seed from a diversity of native plants.* Full restoration includes restoring the entire plant species composition that supports ecological functions and processes. Seed from native flowering plants will help increase diversity, and support pollinators with floral resources that are available at different times of year. Seed also needs to be collected from *Sclerocactus* in order to be able to propagate them for outplanting. Costs are estimated at $1,500 per acre as knowledgeable botanists and multiple trips are needed to gather seed from a diversity of species that best mimics intact site conditions.

5. *Planting seed from habitat specific native plants including wildflowers.* Establishing specific target native plants from the natural community where restoration is to occur is important in establishing the community components and processes (*i.e.,* pollination) important for a functioning ecosystem. Seed will be hand planted or drill seeded immediately after plowing or tilling of the site to ensure good seed-soil contact. Costs for this activity were estimated from two different sources ranging from $1,250 to $2,500 per acre (Schneider 2014) and $500 to $1,000 per acre, or a median cost of $750 per acre (Mike Thomas, Great Bear Restoration, MT, Mar 2014, personal communication). We are using the $750 per acre cost for our mitigation estimates.

6. *Listed Sclerocactus species propagation.* Propagating and planting juvenile to young adult plants will help establish cactus on the restored area. *Sclerocactus* species can take 4-6 years from seed propagation before it can outplanted on a restoration site. Costs for propagating cactus were estimated by Red Butte Garden (R. Reisor, Feb 11, 2014, personal communication), and total $100 per cactus.

7. *Planting propagated Sclerocactus plants. Sclerocactus* that are propagated will be planted at 10 cacti per acre in Level 1 CCAs and 5 cacti per acre in Level 2 CCAs to establish listed *Sclerocactus* species at the restored site. We expect mortality and reduced reproduction from planted *Sclerocactus* so we anticipate final survival and reproduction of 8 *Sclerocactus* in Level 1 CCAs and 4 *Sclerocactus* per acre in Level 2 CCAs. Costs for planting cactus were estimated by Red Butte Garden (R. Reisor, Feb 11, 2014, personal communication) and total $42 per cactus. For restoration activities, five *Sclerocactus* plants would be planted per acre for a cost of $210 per acre.

8. *Planting commercially available habitat specific native plant species seed (twice) including grasses and shrubs.* This task would lead to the establishment of the portion of native plant community that would integrate formerly disturbed areas into the landscape, support ecosystem functions and stabilize the site. The BLM requires establishment of a desired self-perpetuating plant community in their Green River District Reclamation Guidelines (see Objective 1; Attachment 1 *in* BLM 2011) so we have not included these requirements in our mitigation costs. Where these measures are not required as part of BLM reclamation, these costs will apply in our mitigation calculation. In addition, only native, habitat specific plant species will be allowed in listed *Sclerocactus* habitat in order to achieve full ecological restoration. Costs include seed mix purchase and planting of

seed. Costs for purchasing an appropriate seed mix are $500 per acre and include *Artemisia nova*, *Atriplex canescens*, *Pleuraphis jamesii*, *Achnatherum hymenoides*, *Linum lewisii* and *Sphaeralcea munroana* (J. Poulos Apr. 2014, personal communication). Costs for direct seeding are $750 per acre and are discussed above in number 5.

9. *Monitoring.* Monitoring of the restoration site is necessary to determine if the site is proceeding toward ecological restoration goals and to help inform management decisions to ensure restoration goals are met. Monitoring is required as part of BLM's Green River District Reclamation Guidelines (Objective 8) so we have not included them in our mitigation costs. However, we will work with BLM on a project-specific basis to determine the goals, objectives, and requirements of restoration monitoring plans. Where these measures are not required as part of reclamation these costs will apply in our mitigation calculation.

Calculating Acres to be Mitigated:

Mitigation costs are based on the amount of habitat impacted and the quality of that habitat as determined by the U.S. Fish and Wildlife Service and delineated into 3 strata: Level 1 CCAs, Level 2 CCAs, and suitable habitat outside of the CCAs. Mitigation is applied only where impacts cannot be avoided. Mitigation will occur for any impacts occurring within Level 1 CCAs for any surface disturbances. Mitigation will occur in Level 2 CCAs where surface disturbance exceeds 5 percent. Mitigation will occur in suitable habitat where impacts are within 300 ft of listed *Sclerocactus* plants. This habitat mitigation approach does not apply to direct impacts to listed plants. Mitigation for direct impacts are addressed through another mitigation calculation as discussed below.

The amount of habitat impacted will be calculated as follows:

1. For Level 1 CCAs all disturbed acres inside designated Level 1 CCAs will be mitigated. To meet our objective of no disturbance in Level 1 CCAs, we anticipate the only additional disturbance will come from well expansions not new roads or well pads.
2. For Level 2 CCAs the number of acres currently disturbed that are not reclaimed, and exceed the 5 percent disturbance cap will be mitigated.
3. For impacts outside of Level 1 and 2 CCAs and within 300 ft of *Sclerocactus*:
    a. The total acreage of the well pad that is within 300 ft of *Sclerocactus* will be mitigated.
    b. The distance of the Right-of-Way (ROW) where the edge is within 300 ft of *Sclerocactus* for buried and cross country pipelines and 50 ft for hand-laid surface pipelines adjacent to roads multiplied times the width for the stretch of ROW (for a pipeline or road) will be mitigated.

Summary of Mitigation Costs:

Mitigation costs include topographical contouring, soil preparation, seed collection and planting, cactus propagation and planting, and monitoring. These costs vary based on the importance of the three habitat areas for *Sclerocactus*—Level 1 CCAs, Level 2 CCAs, and Suitable Habitat outside of CCAs.

Level 1 CCAs: Mitigation costs per acre in Level 1 CCAs includes costs associated with plowing the soil, amending the soil, propagating *Sclerocactus* and planting at a density of 10 cacti per acre, and collecting seed and planting a diversity of native plant species from adjacent sites. Level 1 CCAs areas support the highest density of *Sclerocactus* thus we have included costs for restoring a high density at 10 *Sclerocactus* per acres assuming some mortality and reduced reproduction from transplanting and poor soils.

Level 2 CCAs: Mitigation costs per acre in Level 2 CCAs includes costs associated with amending the soil, propagating *Sclerocactus* and planting at a density of 5 cacti per acre and collecting seed and planting a diversity of native plant species from adjacent sites.

Suitable habitat: Mitigation costs per acre in suitable habitat includes costs associated with collecting and planting a diversity of native seed and re-establishing biological soil crust by inoculation.

Other costs associated with restoration that are already required and included in BLM's Green River Reclamation Guidelines such as grading of site and seeding and establishment of common native plants commercially available are not included in our mitigation costs because we assume these restoration actions will be conducted as part of BLM's requirements. Where these actions are not required or completed these costs will be included in our total costs for mitigation.

Table 1. *Sclerocactus* compensatory mitigation calculation

Mitigation habitat type	Acres	Cost per acre	Explanation of restoration costs
Level 1 CCA (any level of disturbance)	1.0	$7,510.00	Includes amending soil, cactus propagation and planting (10 cacti per acre), and native species seed collection and planting. Assumes costs for BLM required measures are already being implemented.

Level 2 CCA (over 5% disturbance or within 300 ft of cactus)	1.0	$6,260.00	Includes amending soil, cactus propagation and planting (5 cacti per acre), and native species seed collection and planting. Assumes costs for BLM required measures are already being implemented.
Sclerocactus habitat (Disturbance within 300 ft of cactus)	1.0	$2,550.00	Native species seed collection and planting and biological soil crust inoculation. Assumes costs for BLM required measures are already being implemented.

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Appendix 1 – Newfield-provided Explanation of Mitigation Strategy Components

Mitigation Strategy Components

1) Truck traffic reduction associated with flow line installation
2) Additional interim reclamation of fully down-spaced well pads in Core 1 Areas

1) Truck Traffic Reduction Associated with Flow Line Installation

Daily truck traffic along access roads to well pad locations can result in increased potential for creation of airborne dust generated by vehicles. Airborne dust could inhibit photosynthesis and transpiration in *Sclerocactus* species. Inhibited and reduced rates of photosynthesis could affect the rate of growth, the reproductive capacity of individual plants, and ultimately the ability of these individuals to persist in adjacent areas. Installation of surface flow lines would greatly reduce the number and frequency of vehicles traveling to individual well pad locations, resulting in a decrease in the amount of airborne dust generated by vehicle travel.

2) Additional interim reclamation of fully down-spaced well pads in Core 1 Areas

See Areas (**Figure 7** in the BA Attachment 1), which is a Map of the Fully Down-Spaced Wells in Level 1 Core Conservation which shows the locations of the host pads that could have more extensive interim reclaimed (i.e., pads sizes could be reduced) in the near term should BLM/USFWS allow us to install flowlines to these locations and subsequent construction of larger tank batteries either in the Level 2 Core Area or Outside of the Core Area.

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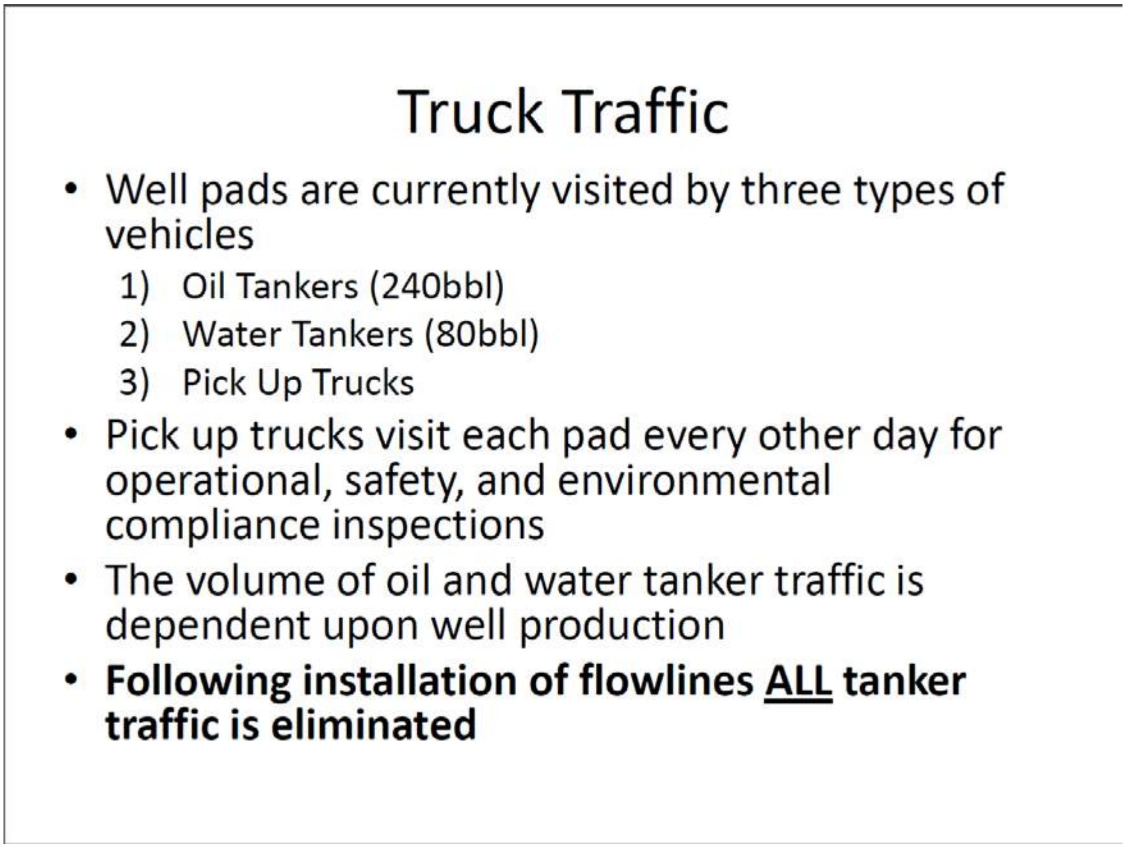
Newfield GMBU EIS
Section 7 Consultation
Reply to USFWS Data Request

November 7, 2014

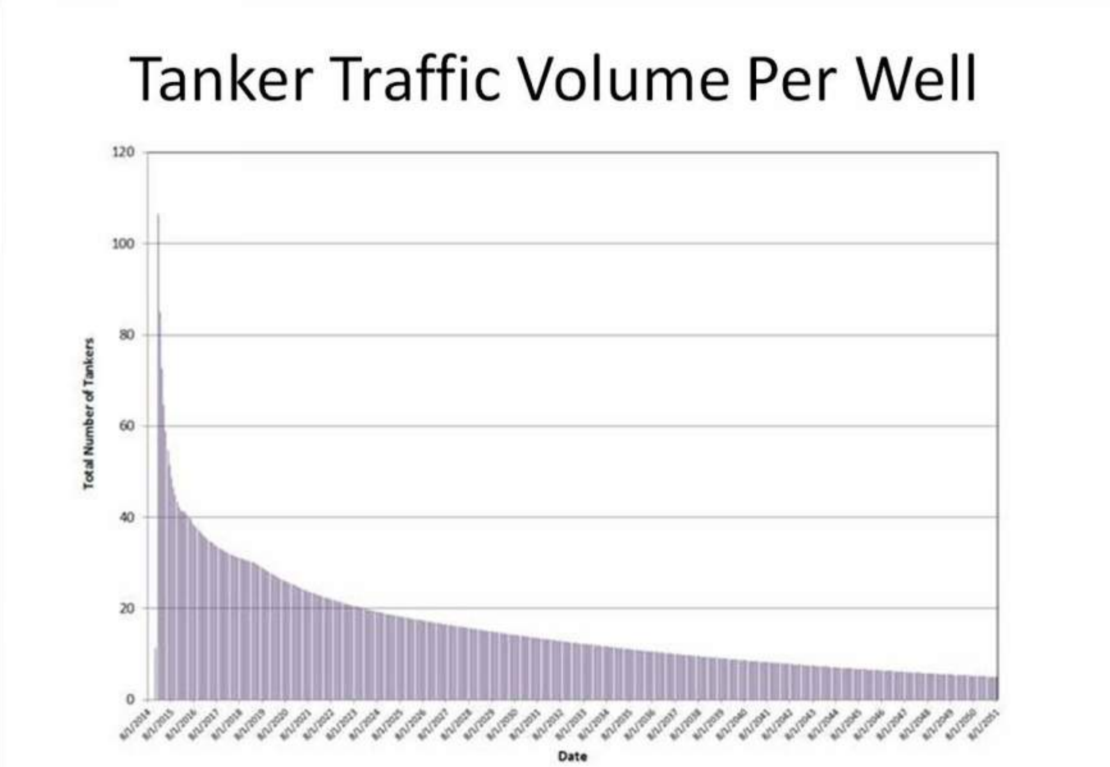
Information Requested by USFWS

- Quantification on truck traffic reductions associated with flowline installation
- Quantification of surface disturbance reductions associated with reclamation of existing disturbance in Level 1 Core Areas
- Information on reclamation success and potential regrowth of cacti in reclaimed areas


Truck Traffic
• Well pads are currently visited by three types of vehicles
1) Oil Tankers (240bbl)
2) Water Tankers (80bbl)
3) Pick Up Trucks
• Pick up trucks visit each pad every other day for operational, safety, and environmental compliance inspections
• The volume of oil and water tanker traffic is dependent upon well production
• Following installation of flowlines ALL tanker traffic is eliminated

Truck Traffic

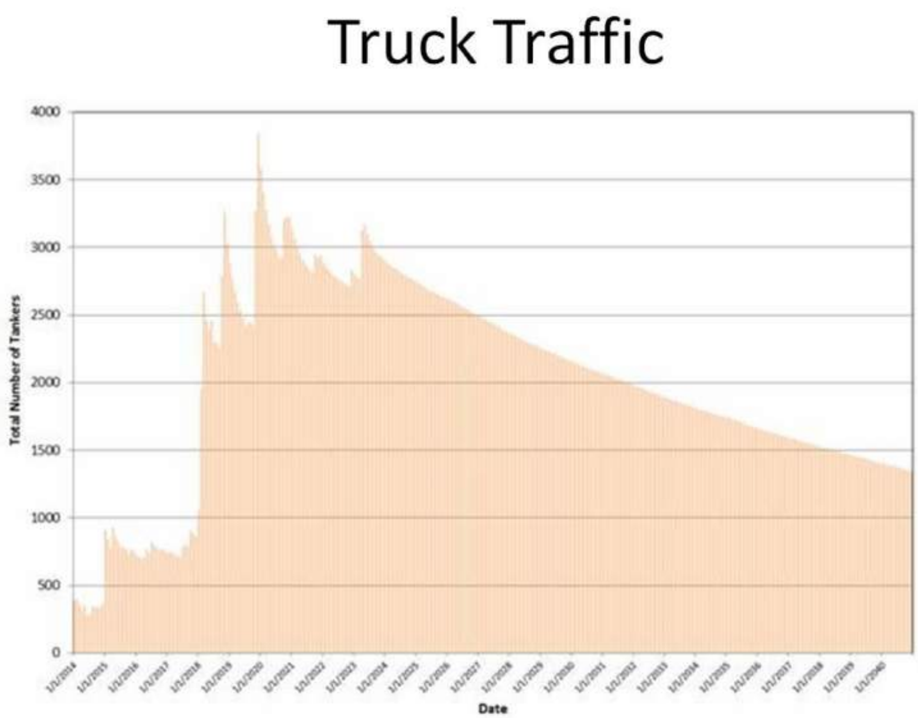
- On average, two tankers collect oil and water from each well twice/day for the first two years of production
- If a pad hosts more than one producing well, then tanker volume would be multiplied by the number of wells on a given pad
- Tanker volume then decreases over time as the well production declines
- A graph that displays the tanker traffic required after a new well is put on production well specific is displayed on the next slide.



Monthly Tanker Traffic in the Core Area Necessary to Remove Produced Oil and Water for a 20-acre Well

Tanker Traffic Volume in Core Area

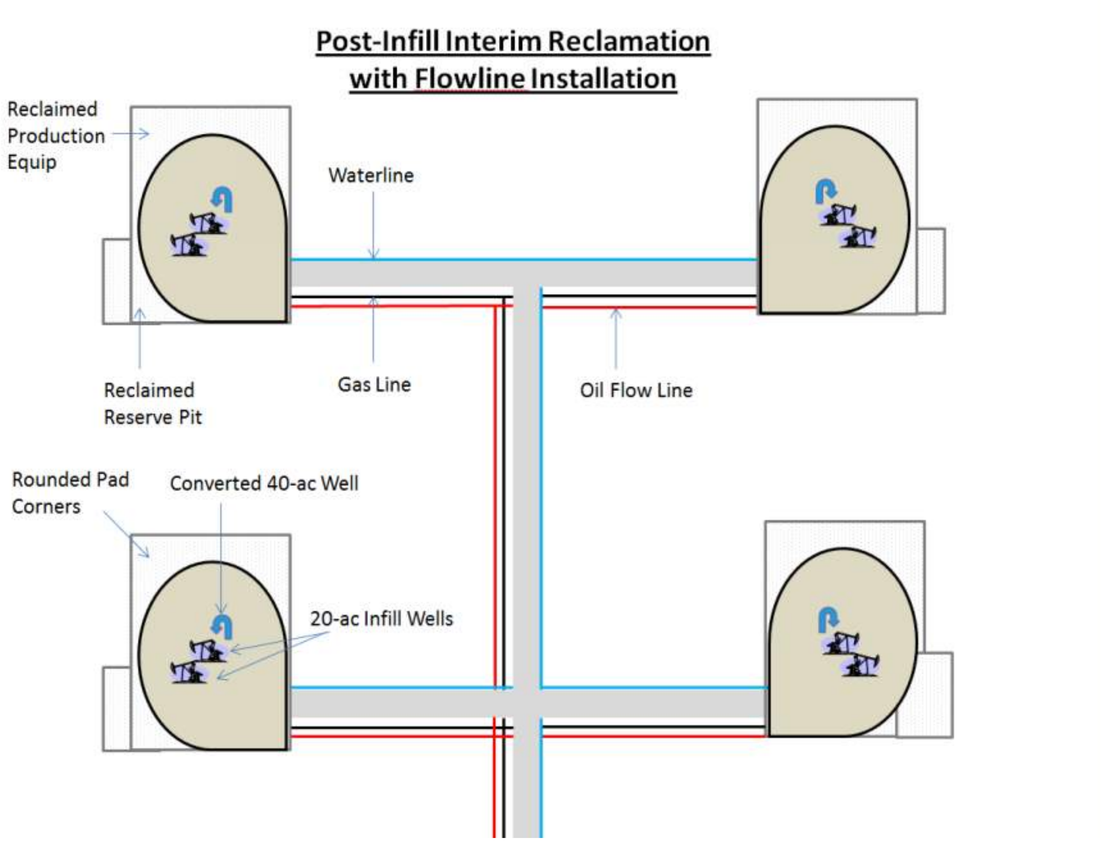
- Currently 340 tanker trucks travel through Level 1 Core Areas each month
- This volume is projected to increase to between 500-700 tanker trucks per month between 2015-2018
- At maximum production truck traffic could increase to over 3000 tanker trucks per month.
- A graph displaying projected tanker traffic volumes over the life of the GMBU Project are displayed on the next slide.

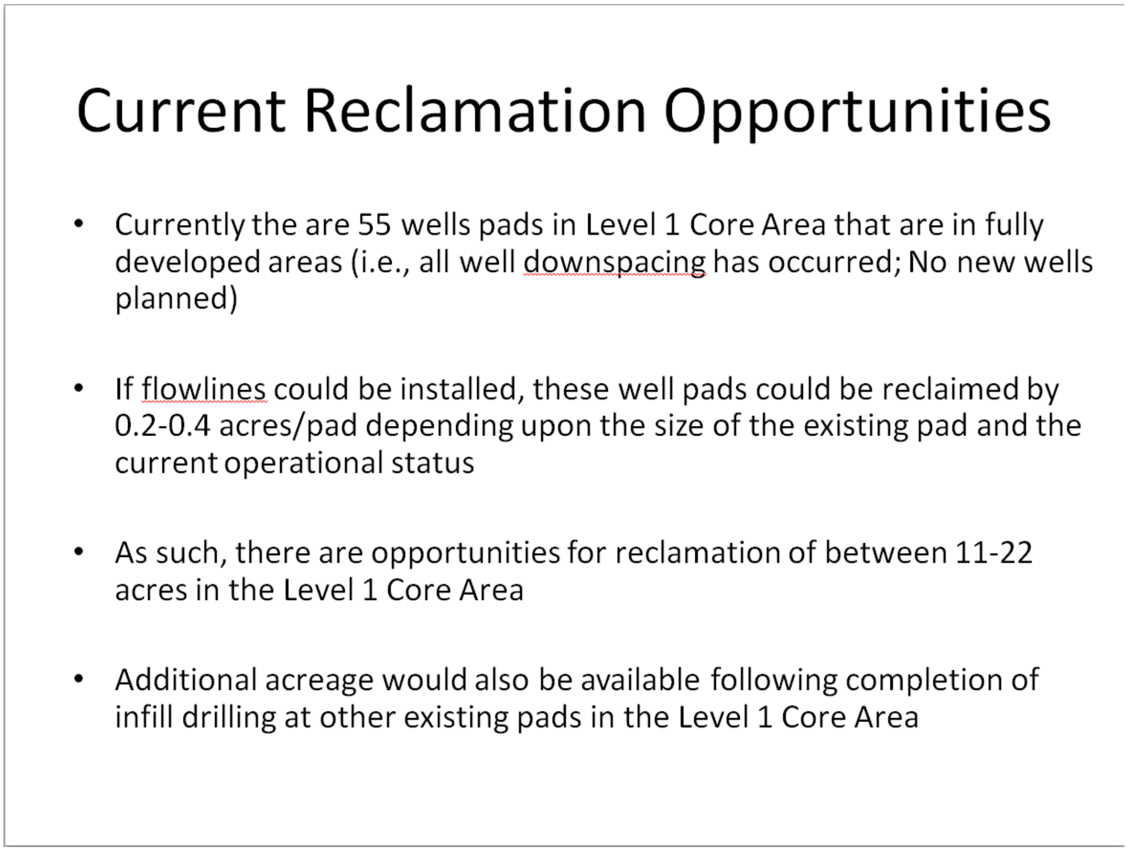


Monthly Tanker Traffic in the Core Area Necessary to Remove Produced Oil and Water

Traffic Reductions Associated with Flowline Installation

- **Following installation of flowlines, ALL tanker truck traffic for the well pad would be eliminated**
- Traffic would then be limited to operational, safety, and environmental compliance inspections which are conducted every other day
- This would be a 95% reduction in total traffic from todays volumes and this percentage would increase over time


Post-Infill Interim Reclamation
with Flowline Installation
Reclaimed
Production
Equip
Waterline
Reclaimed
Reserve Pit
Gas Line
Oil Flow Line
Rounded Pad
Corners
Converted 40-ac Well
20-ac Infill Wells



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Appendix 2 – Cactus Survey for the Pariette Federal 16-28 reclaimed road and pad

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KLEINFELDER
Bright People. Right Solutions.

November 7, 2014

Kirby Carroll
Regulatory Manager
Newfield Exploration Company
1001 17th Street
Suite #2000
Denver, CO 80202

RE: Summary of Reclamation Survey for Pariette Federal #16-28

Dear Mr. Carroll,

At the request of Newfield Exploration Company (Newfield), two qualified Kleinfelder biologists conducted a reclamation survey on October 31, 2014, to determine if *Sclerocactus brevispinus* currently occupy the previously reclaimed Pariette Federal #16-28 well pad and/or access road right-of-way (ROW). Pariette Federal #16-28 is located in Sections 28 and 33 of Township 8 South, Range 18 East, in Uintah County, Utah (**Figure 1**).

This wildcat well was originally owned by Lomax Exploration Company. It was spudded on August 3, 1984, and plugged and abandoned on September 14, 1984. On October 30, 1984, the well pad and access road were reshaped to the original contour and stockpiled topsoil was evenly spread over the disturbed area. These areas were also scarified and left with a rough surface. Broadcast reseeding occurred on November 2, 1984, using a seed mixture approved by the Bureau of Land Management (BLM). The seed mixture included yellow sweetclover (*Melilotus officinalis*, two pounds [lbs] per acre), Ephraim crested wheatgrass (*Agropyron cristatum*, four lbs per acre), green needlegrass (*Stips viridula*, four lbs per acre), and Whitmar beardless bluebunch (*Agropyron spicatum*, four lbs per acre). A harrow was dragged over the seeded area to rake the seeds into the soil and assure seed coverage. A dry hole marker was then put into place.

Kleinfelder biologists systematically walked the previously reclaimed Pariette #16-28 well pad and access road ROW. When cacti were encountered, biologists recorded the population's location using a hand-held Trimble Juno 3B GPS (one to three meter accuracy) and took digital photographs. A few general landscape photographs of the reclaimed area were also taken at the end of the survey to visually document reclamation progress at Pariette Federal #16-28. These photographs were taken where the access road joins the well pad.

1801 California Street, Suite 1100, Denver, CO 80202 **p** | 303-237-6601 **f** | 303-237-6602

Summary of Results

Four live *Sclerocactus brevispinus* populations (six individual cacti total) were documented during the survey. Two of the four populations were growing on previously reclaimed areas. The other two populations were observed opportunistically on the margin of previously reclaimed areas. Because the reclaimed vegetation communities so closely resembled the natural landscape, it was difficult to discern portions of the reclamation boundary.

Table 1 summarizes the results of this field effort.

Table 1. Survey Results

Population ID Number	Number of Individual Cactus	Location	Latitude	Longitude
1	1	Reclaimed Road ROW	-109.893	40.0834
2	2	Reclaimed Well Pad	-109.892	40.08334
3	1	Opportunistic Observation	-109.895	40.08092
4	2	Opportunistic Observation	-109.895	40.0809

Digital photographs of the four cacti populations are included in the photo log at the end of this memorandum (**Figure 2**).

Two general landscape photographs are included in the photo log at the end of this memorandum (**Figure 3**). During post-processing, Kleinfelder added a thick black line to these photographs to delineate reclaimed surfaces from the undisturbed, natural landscape. As depicted in these photographs, the character of the landscape and vegetation communities has largely been restored to pre-disturbance conditions.

It should be noted that any pin flags in the general landscape photographs were reference points for the surveyors and do not indicate the presence of cactus.

Limitations

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same locality, under similar conditions and at the date the services were provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data as agreed upon in the scope of services. It is possible that field conditions could vary in the future and results may not be fully repeatable. Kleinfelder makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of services provided.

This report may be used only by Newfield and designated agencies, and only for the purposes stated for this specific engagement within a reasonable and acceptable time from its issuance.

Closing

We appreciate the opportunity to submit this technical memorandum for reclamation associated with Pariette Federal #16-28. If you have any questions or need additional information, please contact Karen Simpson at (303) 297-5725.

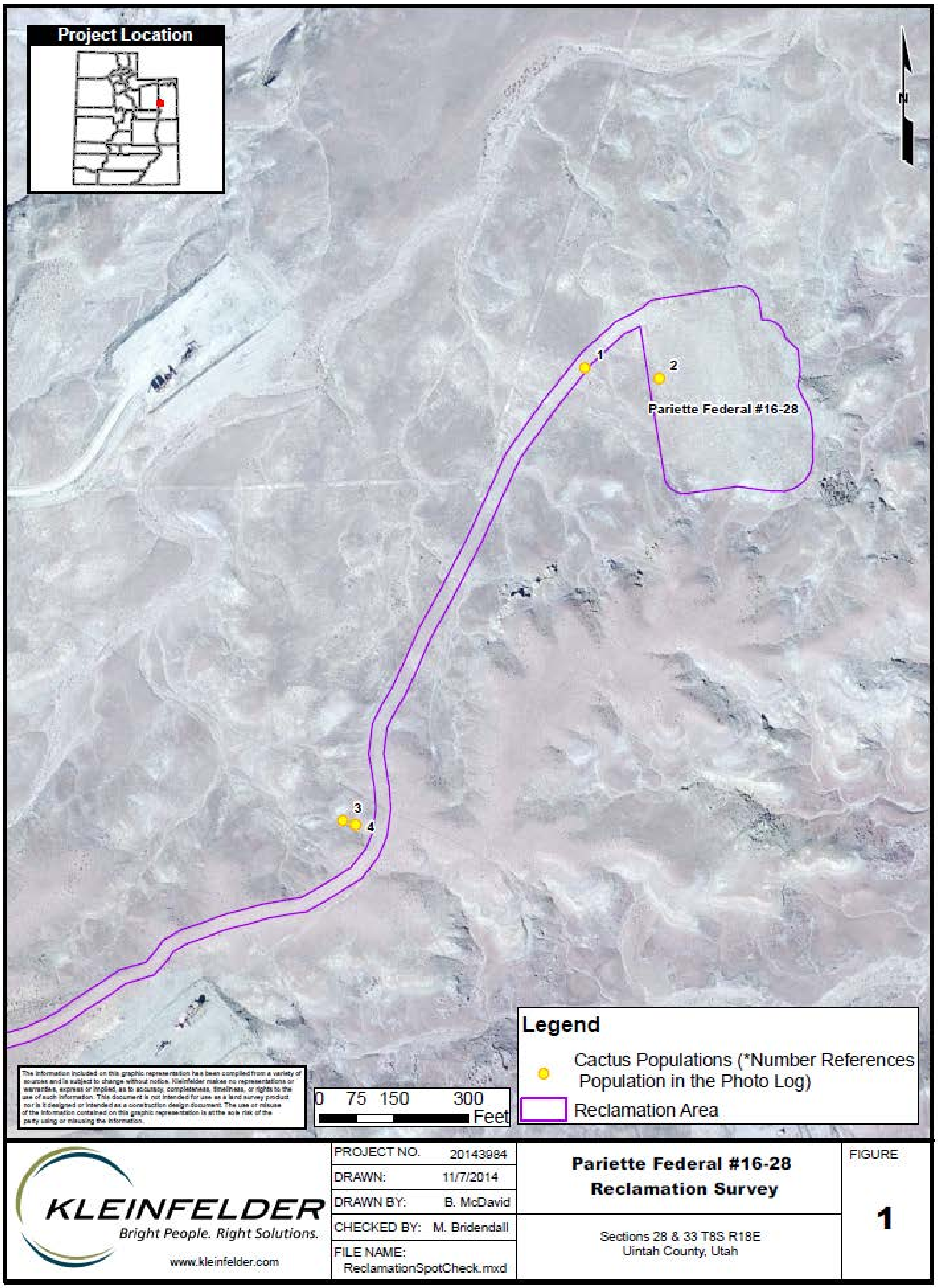
Respectfully submitted,

Melissa Bridendall
Project Professional/NEPA Specialist
Kleinfelder, Inc.

Karen Simpson
Project Manager II
Kleinfelder, Inc.

Figures

1801 California Street, Suite 1100, Denver, CO 80202 **p** | 303-237-6601 **f** | 303-237-6602


Project Location
1
2
Pariette Federal #16-28
3
4
Legend
Cactus Populations (*Number References Population in the Photo Log)
Reclamation Area
0 75 150 300
Feet
KLEINFELDER
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PROJECT NO. 20143984
DRAWN: 11/7/2014
DRAWN BY: B. McDavid
CHECKED BY: M. Bridendall
FILE NAME: ReclamationSpotCheck.mxd
Pariette Federal #16-28
Reclamation Survey
Sections 28 & 33 T8S R18E
Uintah County, Utah
FIGURE
1

Population 1 – Observed on
Reclaimed Road Right-of-Way (ROW)

Population 2 – Observed on
Reclaimed Well Pad

Population 3 – Opportunistic Observation, Located in
Vicinity of, but Outside of Reclaimed Road ROW

Population 4 – Observed Observation, Located in
Vicinity of, but Outside of Reclaimed Road ROW

KLEINFELDER Bright People. Right Solutions. www.kleinfelder.com	PROJECT NO.	20143984	**Pariette Federal #16-28** **Reclamation Survey** **Photo Log - Cacti Populations**	FIGURE
	DRAWN:	11/7/2014		**2**
	DRAWN BY:	M. Bridendall		
	CHECKED BY:	K. Simpson	Sections 28 & 33 T8S R18E Uintah County, Utah	
	FILE NAME: Pariette Federal #16-28 Log			

East

West

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PROJECT NO.	20143984
DRAWN:	11/7/2014
DRAWN BY:	M. Bridendall
CHECKED BY:	K. Simpson
FILE NAME: Pariette Federal #16-28 Log	

Pariette Federal #16-28
Reclamation Survey
Photo Log—Landscape

Sections 28 & 33 T8S R18E
Uintah County, Utah

FIGURE
3

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ATTACHMENT G Applicable Measures from Vernal RMP Appendices K, L, and R

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Applicable Measures from the VFO RMP/ROD Appendices K, L, and R

APPENDIX K. SURFACE-DISTURBING STIPULATIONS BENEFITING HOOKLESS CACTUS AND UTE LADIES' TRESSES

There are no surface-disturbing stipulations applicable to Uinta Basin hookless cactus, Pariette cactus or Ute ladies' tresses in this appendix.

APPENDIX L. APPLICABLE COLORADO RIVER FISH CONSERVATION MEASURES

Endangered Fish Of The Upper Colorado River Drainage Basin

1. Water production will be managed to ensure maintenance or enhancement of riparian habitat;
2. Avoid loss or disturbance of riparian habitats;
3. Where technically and economically feasible, use directional drilling or multiple wells from the same pad to reduce surface disturbance and eliminate drilling in suitable riparian habitat. Ensure that such directional drilling does not intercept or degrade alluvial aquifers;
4. Implement the Utah Oil and Gas Pipeline Crossing Guidance (from BLM National Science and Technology Center);
5. Drilling will not occur within 100-year floodplains of rivers or tributaries to rivers that contain listed fish species or critical habitat; and,
6. In areas adjacent to 100-year flood plains, particularly in systems prone to flash floods, analyze the risk for flash floods to impact facilities, and use closed loop drilling, and pipeline burial or suspension according to the Utah Oil and Gas Pipeline Crossing Guidance, to minimize the potential for equipment damage and resulting leaks or spills.
7. All water depletion amounts must be reported to BLM.

APPENDIX R. BMPs BENEFITING HOOKLESS CACTUS AND UTE LADIES' TRESSES

1) Interim reclamation of the well and access road will begin as soon as practicable after a well is placed in production. Facilities will be grouped on the pads to allow for maximum interim reclamation. Interim reclamation will include road cuts and fills and will extend to within close proximity of the wellhead and production facilities.

2) All new roads will be designed and constructed to a safe and appropriate standard, "no higher than necessary" to accommodate intended vehicular use. Roads will follow the contour of the land where practical. Existing oil and gas roads that are in eroded condition or contribute to other resource concerns will be brought to BLM standards within a reasonable period of time.

3) In developing oil and gas fields, all production facilities may be centralized to avoid tanks and associated facilities on each well pad where necessary to address resource issues.

4) Multiple wells will be drilled from a single well pad wherever feasible.

5) Bioremediating oil field wastes and spills; and

6) Using common utility or Right-of-Way corridors containing roads, powerlines, and pipelines.

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Applicant Committed Conservation Measures
All general applicant-committed environmental protection measures as listed in Section 2.3.1.4 and Appendix G of the BA will be implemented. In addition, the following applicant-committed conservation measures were established in email correspondence on July 17, 2015, July 18, 2015, and August 6, 2015.

Wetlands and Waters of the U.S

- If proposed activities would result in the temporary or permanent placement of dredge or fill material into existing wetlands or Waters of the U.S., Newfield would adhere to the Army Corp of Engineers (ACE) Nationwide Permit General Conditions as well as the ACE Final Sacramento District Nationwide Permit Regional Conditions for Utah.

100-Year Floodplains
- The width of the construction areas shall be made as small as possible through the 100-year floodplains.
- Construction activities in 100-year floodplains will not occur during active flooding events.
- All staging areas and stockpiled material will be located outside of the 100-year floodplains.
- The contractor will remove all construction material due to construction in the 100-year floodplains at the end of the project.
- Equipment should be cleaned to remove noxious weeds/seed and petroleum products prior to moving on to the 100-year floodplain.
- If fill materials are brought into the 100-year floodplain they will be free of waste, pollutants, and noxious weeds/seeds.
- Employees and contractors will be instructed to travel at appropriate speeds to limit disturbance to soils on unpaved roads in 100-year floodplains.
- Sediment control measures will be in conformance with the project's Storm Water Pollution Prevention Plan.

Colorado River Fish

- Construction activities in the 100-year floodplain of the Green River will be timed to reduce impacts to seasonal fish movements, spawning activity, and rearing activity by avoiding construction from April 1 through August 31.
- No work will occur directly in the Green River or other rivers that are considered to be critical habitat for listed Colorado River fish.
- Best Management Practices (BMPs) should be used to minimize sedimentation, temporary erosion of stream banks, and needless damage or alteration to the Green River streambed. BMPs should also ensure construction related byproducts do not enter the riverine ecosystem that will cause negative impacts to aquatic organisms.
- Construction activities in designated critical habitat of the listed Colorado River fish will not occur during active flooding events (when the water level rises more than 6 inches above the normal wetted channel). If construction materials are displaced by

high flow the applicant will contact our office (currently Stephanie Graham, 801-975-3330; ext. 155) as soon as possible to coordinate the least intrusive retrieval methods.

- No more than 1 acre of ground disturbance will occur within the critical habitat of listed Colorado River fish.
- Temporary and permanent construction-related impacts to Colorado pikeminnnow and razorback sucker critical habitat will be addressed by revegetation of construction affected areas.
- Imported and site source materials will be stored in the staging area away from the 100-year floodplains of the Green River. For chemicals being used on-site, the contractor or responsible representative shall provide watertight tanks or barrels for the storage and disposal of chemical pollutants, including those that are produced as byproducts of the construction activities, such as drained lubricating or transmission fluids, grease, or soaps. Upon completion of construction work, these containers will be removed from the action area and their contents disposed of at a designated disposal location.
- Machinery will be fueled offsite or in a confined, designated area to prevent spillage into any surface water. Refueling will not occur within the 100-year floodplain of the Green River.
- Contaminant control measures will be installed to prevent contaminants release into the Green River channel.
- Sediment control measures will be implemented to prevent project-related sediment from entering the critical habitat of the flowing stream channel.

Sclerocactus

- The Sclerocactus Strategy (Appendix A) will be followed.

Yellow-billed Cuckoo

- Surface disturbing activities will be sited 0.5 mile or more from suitable habitat whenever possible.
- If proposed construction would occur within 0.5 mile of riparian habitat, the habitat will be analyzed in accordance *FWS's Yellow Billed Cuckoo Suitable Habitat Identification Guidelines* to determine habitat suitability. Delineated suitable habitat will be submitted as a shape file to USFWS's Utah Field Office to identify survey needs.
- Protocol level breeding season surveys are required in suitable habitat that is within 0.5 miles of new construction prior to operations. All surveys must be conducted by permitted individual(s).
- Construction and drilling activity will be limited to the time period September 1 – May 31 whenever possible.
- If construction is proposed during June-August, protocol level breeding season surveys must be conducted when proposed activity is within 0.5 mile of suitable habitat. All surveys must be conducted by permitted individual(s).
    - If habitat is occupied, no construction activity will occur between June 1 and August 31.

    - If the area is unoccupied, then the Authorized Officer may authorize the commencement of activity.
- If construction activities are sited within occupied habitat, the following will be implemented:
    - Machinery will be equipped with noise mufflers to minimize increases in baseline noise levels at the source;
    - Insecticides and herbicides will not be used in occupied habitat to preclude loss of prey base for cuckoo;
    - Sediment control measures will be implemented to prevent project related sediment from moving downstream.

Ute Ladies'- Tresses

- The edge of surface disturbing activities will be sited 300 feet or more from suitable habitat whenever possible. If possible, surface pipelines will be laid such that a 50-foot buffer exists between the edge of the right of way and suitable habitat, using stabilizing and anchoring techniques when the pipeline crosses habitat to ensure the pipelines do not move towards the habitat.
- If suitable habitat is determined to be present within 300 feet of the proposed surface disturbance, surveys will be conducted within suitable habitat to determine occupancy. Surveys:
    - Must be conducted by qualified individual(s) and according to Service accepted survey protocols,
    - Will be conducted in all suitable habitat within 300 feet of the area proposed for surface disturbance,
    - Will be conducted prior to initiation of project activities and within the same growing season, at a time when the plant can be detected, and during appropriate flowering periods (usually August 1st and August 31st in the Uinta Basin; however, surveyors should verify that the plant is flowering by contacting a BLM or FWS botanist or demonstrating that the nearest known population is in flower),
    - Will include, but not be limited to, plant species lists, habitat characteristics, source of hydrology, and estimated hydroperiod
    - Will be valid for three consecutive years following the last survey.
- If suitable habitat is deemed unoccupied, and direct disturbance to suitable habitat is not avoidable the following measures will be implemented:
    - All areas will be re-vegetated with species approved by USFWS and BLM botanists.
    - Avoid soil compaction in Ute ladies'-tresses habitat.
    - The upper part of the soil profile shall be salvaged and retained as intact as possible during construction. The soil profile shall be repositioned on the appropriately grazed backfilled trench to maintain a level soil surface and consistent, pre-construction hydrology.
    - Minimize soil disturbance by operating heavy equipment on top of temporary earth fills.
    - Minimize soil erosion with the use of silt fences.

  - Equipment will be cleaned to remove noxious weeds/seeds and petroleum products prior to moving on site.
  - Fueling of machinery will occur outside of suitable habitat.
  - Materials will not be stockpiled in the suitable habitat.
  - Fill materials will be free of waste, pollutants, and noxious weeds/seeds.
  - Ingress and egress access will be kept to a minimum.
  - Excavated soils will be sorted into sub soils and top soils. When backfilling a disturbed site top soils will be placed on top to provide a seed bed for native plants.
  - Disturbed areas will be monitored and controlled for noxious and undesirable plant species during the life of the project.
- Reinitiation of Section 7 consultation with our office will be sought if project activities are proposed within occupied habitat (within 300 feet of a Ute Ladies tresses individual).

Howard, Stephanie <showard@blm.gov>

Newfield BA

Howard, Stephanie <showard@blm.gov> Mon, Jun 15, 2015 at 3:41 PM
To: "Graham, Stephanie" <stephanie_graham@fws.gov>
Cc: Christine Cimiluca <ccimiluc@blm.gov>, Daniel Emmett <demmett@blm.gov>, Paul Abate <paul_abate@fws.gov>, Larry Crist <Larry_Crist@fws.gov>, Laura Romin <laura_romin@fws.gov>

Just realized I forgot to respond to # 3. Your confusion was caused by a typo. Sorry about that. The text should state the following. Let me know what we need to do to fix it. Thanks.

Uinta Basin Hookless Cactus and Pariette Cactus

As previously discussed in Chapter 2, one of the primary objectives of Alternative D is to reduce surface disturbance within *Sclerocactus* habitat and specifically, within the Upper and Lower Pariette Core Conservation Areas. However, for analysis purposes, the Alternative evaluated the most conservative (i.e., worst-case) scenario. Under this conservative scenario, implementation of Alternative D could directly result in the disturbance of approximately 4,295 acres of potential habitat for *Sclerocactus* species within the MBPA, which represents approximately 1 percent of the total potential habitat for *Sclerocactus* species across their entire range. Following construction, approximately 2,201 acres (51 percent) of land associated with the construction of the well pads, access roads, and pipeline ROWs not needed for operation purposes would be reclaimed. If reclamation is successful, the long-term disturbance to *Sclerocactus* species' habitat under Alternative D would be reduced to approximately 2,094 acres, which is approximately 1,298 acres (62 percent) less than that under the Proposed Action.

Under Alternative D, no new surface disturbance or well pad expansions would occur within Level 1 Core Conservation Areas except as allowed under the FWS/Newfield Conservation, Restoration, and Mitigation Strategy for the Pariette and Uinta Basin Hookless Cactus (Appendix J – Biological Assessment Attachment F). Per the strategy in Level 1 areas, GIS calculations show conceptually mapped initial disturbance of 116 acres from limited well pad expansions and pipelines buried adjacent to existing roads and up to 20 acres of new disturbance from eight new well pads. Following interim reclamation this would be reduced to about 57 acres. In Level 2 areas, GIS calculations show conceptually mapped disturbance of approximately 870 acres, which would be reduced to about 360 acres after interim reclamation. Surface disturbance in Level 2 areas would be minimized to the greatest extent practicable by using existing infrastructure (i.e., access roads and pipelines) and directional drilling from multi-well pads that would either require the expansion of existing well pads or the construction of a limited number of new multi-well pads. Concentrated use of existing well pads would reduce fragmentation of *Sclerocactus* habitat. If reclamation is successful, the long-term disturbance to Level 1 and Level 2 Core Conservation Areas under Alternative D would be reduced to approximately 57 acres and 360 acres , respectively. Similarly, Alternative D's focused use of existing well pads would reduce the level of habitat fragmentation from new roads and pipeline corridors as compared to the Proposed Action.

Indirect and dispersed direct effects to *Sclerocactus* species (including an increased potential for the invasion and establishment of noxious weed species, impacts from herbicides used to control invasive plants in the MBPA, and possible reductions in pollination or seed dispersal from a larger road network that could result in isolated populations due to habitat fragmentation and increased dust) would be similar to that previously discussed under the Proposed Action. However, the magnitude of indirect impacts would be comparatively less, because 3,467 fewer acres of potential habitat for *Sclerocactus* species would be impacted in the long term under Alternative D, as compared to those under the Proposed Action.

Additional species-specific conservation measures for *Sclerocactus* species under Alternative D, beyond those included in **Section 4.10.2**, include provisions to avoid all new surface disturbances to Level 1 Core Conservation Areas (except as allowed by the FWS/Newfield Conservation, Restoration, and Mitigation Strategy for the Pariette and Uinta Basin Hookless Cactus (Appendix J Biological Assessment - Attachment F)), and to limit the disturbance to Level 2 Core Conservation Areas through the use of existing multi-well pads and roads and increased use of directional drilling technology (**Section 2.6.2**). The proposed mitigation measures for *Sclerocactus* species are described in **Section 4.10.2.5**.

Although these measures would minimize the impacts of the action to *Sclerocactus* species, larger landscape-level changes, such as increased habitat fragmentation and habitat loss, pollinator disturbance, changes in erosion and water runoff, and increased weed invasion, cannot be entirely negated. These disturbances could continue to negatively impact *Sclerocactus* species throughout the MBPA, although at a substantially reduced level as compared to those under the Proposed Action. An undetermined number of individual plants could be lost; therefore, implementation of Alternative D ***may affect, is likely to adversely affect*** the Uinta Basin hookless cactus and Pariette cactus and their habitats.

[DM1]Stephanie, please note this change.

Stephanie Howard
NEPA Coordinator
Bureau of Land Management
Vernal Field Office
170 S 500 E
Vernal, UT 84078
phone (435) 781-4469
fax (435) 781-4410

[Quoted text hidden]

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Green River District
Vernal Field Office
170 South 500 East
Vernal, UT 84078
http://www.blm.gov/ut/st/en/fo/vernal.html

JUL 17 2015

IN REPLY REFER TO:
3160, 6841 (UTG010)

Memorandum

To: Larry Crist
Utah Supervisor, Utah Field Office, Ecological Services

From: Jerry Kenczka
Acting District Manager, Green River District

Subject: Change in Determination of Formal Consultation on Newfield Exploration Corporation Monument Butte Oil and Gas Development Project in Uintah and Duchesne Counties, Utah Environmental Impact Statement

In response to a question received from your staff, we have reviewed our determinations of impacts to critical habitat for the Colorado River Fish Species. We have discovered that our Environmental Impact Statement and Biological Assessment for the above project contained an incorrect determination. Therefore, we are changing our determination for critical habitat impacts as follows.

EIS page 88

- Delete: The potential also exists that portions of the designated critical habitat for these species may be adversely modified.
- Add: In addition, implementation of Alternative D *may affect, is likely to adversely affect* critical habitat due to the construction of a 1-acre water collector well in the 100-year floodplain of the Green River.

EIS page 98

- Delete: Implementation of Alternative D, combined with other past, present, and reasonably foreseeable activities in the CIAA, could also result in the adverse modification of designated critical habitat for the Colorado River fish in the Green River by increasing erosion and sediment yield.
- Add: Implementation of Alternative D, combined with other past, present, and reasonably foreseeable activities in the CIAA, could also adversely affect designated critical habitat for the Colorado River fish in the Green River by increasing erosion and sediment yield.

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RECEIVED
SEP 2015

IN REPLY REFER TO:
3160, 6841 (UTG010)

Memorandum

To: Larry Crist
Utah Supervisor, Utah Field Office, ecological Services, U.S. Fish & Wildlife Services, Salt Lake City, Utah

From: Richard Rymerson
District Manager, Green River District

Subject: Additional Committed Measures for the Newfield Exploration Corporation Monument Butte Oil and Gas Development Project in Uintah and Duchesne Counties, Utah Environmental Impact Statement

This memo transmits the final Conservation Measures committed to by the BLM as part of their Newfield Exploration Company Monument Butte Oil and Gas Development Project Environmental Impact Statement. These measures are listed below and contain the wording recommended by your office. Please consider these measures as integral to the Agency Preferred Alternative for which you are currently preparing a Biological Opinion pursuant with Section 7 of the Endangered Species Act of 1973. BLM will incorporate these measures into the BLM's Record of Decision for this project as Conditions of Approval. BLM will implement these measures on a site-specific basis as necessary based on presence or proximity of any future land use applications (APDs, Sundries, etc) to the relevant habitats.

Colorado River Fish

5. Materials should not be stockpiled in the 100-year floodplain or wetlands.
6. Mitigation for permanent impacts to designated critical habitat of the Colorado River Fish will be achieved through completion of a riparian restoration project implemented at a ratio of 3:1 for all permanently disturbed areas. Temporary impacts will be mitigated at a 2:1 ratio for all disturbed areas. For every 1 acre of temporary disturbance 2 acres will be restored. For every 1 acre of permanent disturbance, 3 acres will be restored.
7. Disturbed areas in Colorado River Fish Critical Habitat will be restored to natural grade, tilled if necessary to loosen compacted soils, and planted with a combination of native, certified weed-free riparian trees, shrubs, and other vegetation. The applicant will work

with the U.S. Fish and Wildlife Service Utah Ecological Services Field Office (USFWS) to complete a restoration plan. This plan will include planting willows, cottonwoods, or other native vegetation, removal of noxious weeds, and other measures to be determined on a site-specific basis. The planting success criteria and monitoring will be coordinated with the USFWS Utah Ecological Services Field Office.

8. The mitigation restoration project will occur within one year post-construction.

Western Yellow-Billed Cuckoo

7. Suitable habitat within 0.5 mile of the action area will be identified and delineated on a map in accordance with the USFWS Utah Field Office *Guidelines for identification of suitable breeding and nesting habitat for western yellow-billed cuckoo in Utah*. Delineated suitable habitat will be submitted by the BLM as a shape file to USFWS's Utah Field Office.
8. If any project feature is proposed within 0.5 mile of suitable habitat, protocol level breeding season surveys (*A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo, Final Draft 22 April 2015)* will be conducted prior to any surface disturbance within 0.5 mile of suitable habitat.
9. For any project feature proposed within a 0.5 mile buffer of suitable habitat, the following measures will be implemented to minimize the effects of noise, human disturbance, and light pollution:
    a. Construction and drilling activity shall occur outside the breeding and nesting season for western yellow-billed cuckoo (September 1 – May 31).
    b. Facilities and structures that generate short or long-term noise above ambient conditions shall be fitted with noise-abating equipment to preclude increases in noise levels (above ambient conditions) at the edge of suitable habitat.
    c. Implement lighting with full cut off optics (no light above the 90-degree angle), short heights, light shielding, low illumination accent lighting, timers, and motion sensors to focus non-target lighting downwards on target areas and away from suitable habitat.
10. Vegetation management, including removal, mowing, drive-and-crush, or pesticide application, will not occur within 300 feet of suitable habitat. Pesticides include herbicides and insecticides.
11. Any temporary disturbance within suitable habitat for western yellow-billed cuckoo shall be reclaimed to preclude invasion of noxious plants, such as tamarisk and Russian olive.
12. Any permanent impacts to suitable habitat for western yellow-billed cuckoo within the project area shall be offset at a 3:1 acreage ratio. For every 1 acre of new disturbance within suitable habitat, 3 acres will be restored. Restoration may include treatment of noxious weeds, planting of native cottonwoods and willows, and other measures that benefit yellow-billed cuckoos.

Ute Ladies'-Tresses

5. The edge of surface disturbing activities will be sited 300 feet or more from suitable habitat. Surface pipelines will be laid such that a 50-foot buffer exists between the edge of the right of way and suitable habitat, using stabilizing and anchoring techniques when the pipeline crosses habitat to ensure the pipelines do not move towards the habitat.
6. If suitable habitat is determined to be present within 300 feet of the proposed surface disturbance and the project cannot avoid suitable habitat to maintain the 300 foot buffer, surveys will be conducted within suitable habitat to determine occupancy. Surveys:
    a. Must be conducted by qualified individual(s) and according to USFWS accepted survey protocols,
    b. Will be conducted in all suitable habitat within 300 feet of the area proposed for surface disturbance,
    c. Will be conducted prior to initiation of project activities during appropriate flowering periods (usually August 1st to August 31st in the Uinta Basin; however, surveyors should verify that the plant is flowering by contacting a BLM or USFWS botanist or demonstrating that the nearest known population is in flower),
    d. Will include, but not be limited to, plant species lists, habitat characteristics, source of hydrology, and estimated hydroperiod
    e. Will be conducted for at least 1 year prior to any USFWS-defined temporary disturbance in suitable habitat (e.g., overland travel to access geotechnical boring location).
    f. Will be conducted for three consecutive years prior to any USFWS-defined permanent disturbance (e.g., road widening, new road construction, placement of other infrastructure). Suitable habitat will be deemed unoccupied if no plants are detected in the three consecutive years of surveys. The surveys will be valid for three consecutive years following the last survey.
    g. If three consecutive years of surveys cannot be performed prior to any USFWS-defined permanent disturbance, the applicant and BLM will reinitiate Section 7 consultation with our office.
7. If suitable habitat is deemed unoccupied, and direct disturbance to suitable habitat is not avoidable the following measures will be implemented:
    l. All areas will be re-vegetated with species approved by USFWS and BLM Authorized Officer.
    m. The upper part of the soil profile shall be salvaged and retained as intact as possible during construction. The soil profile shall be repositioned on the appropriately backfilled trench to maintain a level soil surface and consistent, pre-construction hydrology.
    n. Minimize soil disturbance by operating heavy equipment on top of temporary earth fills.

o. Minimize soil erosion with the use of silt fences.
p. Equipment will be cleaned to remove noxious weeds/seeds and petroleum products prior to moving on site.
q. Fueling of machinery will occur outside of suitable habitat.
r. Materials will not be stockpiled in the suitable habitat.
s. Fill materials will be free of waste, pollutants, and noxious weeds/seeds.
t. Ingress and egress access will be kept to a minimum.
u. Excavated soils will be sorted into sub soils and top soils. When backfilling a disturbed site top soils will be placed on top to provide a seed bed for native plants.
v. Disturbed areas will be monitored and controlled for noxious and undesirable plant species during the life of the project.

8. Reinitiation of Section 7 consultation with our office will be sought if project activities are proposed within occupied habitat (within 300 feet of a Ute Ladies tresses individual).

If you have any questions or need additional information, please contact Stephanie Howard, NEPA Coordinator, at (435)781-3414, Christine Cimiluca, Botanist at (435)781-4454, or Brandon McDonald, Wildlife Biologist at (435)781-4449.

Final Technical Report

Far-Field Modeling for the Newfield Exploration Corporation Monument Butte Oil and Gas Development Project Environmental Impact Statement

Prepared for:

Bureau of Land Management
Vernal Field Office
170 South 500 East
Vernal, UT

Prepared by:

Dennis McNally
Cyndi Loomis
Alpine Geophysics, LLC
7341 Poppy Way
Arvada, Colorado 80007

22 April 2015

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List of Acronyms

AAQS	Ambient Air Quality Standard
AGL	Above Ground Level
ANC	Acid Neutralization Capacity
AQRV	Air Quality Related Value
ARMS	Air Resource Management Strategy
BLM	Bureau of Land Management
CAA	Clean Air Act
CB05	Carbon Bond version 05
CEMS	Continuous Emissions Monitoring System
CENRAP	Central Regional Air Planning Association
CMAQ	Community Multiscale Air Quality model
DDV	Delta Deci-view
DEIS	Draft Environmental Impact Statement
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FEIS	Final Environmental Impact Statement
FY	Future Year
GOSP	Gas Oil Separation Plant
GMBU	Greater Monument Butte Unit
IAS	Impact Assessment Suite
LCP	Lambert Conformal Projection
MATS	Modeled Attainment Test Software
MB	Monument Butte
Mbbl	Million Barrels
MBPA	Monument Butte Project Area
MEGAN	Model of Emissions of Gases and Aerosols in Nature
MMBO	Million Barrels of Oil
MMCF	Million Cubic Feet
NAAQS	National Air Quality Standard
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NGL	Natural Gas Liquid
NOx	Oxides of Nitrogen
OTB	On The Books
PM	Particulate Matter
PSD	Prevention of Significant Degradation
ROD	Record of Decision
ROW	Right of Way
RPO	Regional Planning Organization
SCC	Source Category Code

SITLA	State Institutional Trust Lands Administration
SMOKE	Sparse Matrix Operator Kernel Emissions model
TcF	Trillion Cubic Feet
VFO	Vernal Field Office
UDAQ	Utah Division of Air Quality
USFWS	United States Fish and Wildlife Service
VISTAS	Visibility Improvement State and Tribal Association of the Southeast
VOC	Volatile Organic Compounds
VMT	Vehicle Miles Traveled
WRAP	Western Regional Air Partnership
WRF	Weather Research Forecasting meteorological model

1 INTRODUCTION

This report describes the process and results of a project specific far-field impact analysis for the Bureau of Land Management (BLM), Vernal Field Office (VFO), Environmental Impact Statement (EIS) for the Newfield Exploration Corporation Monument Butte Oil and Gas Development Project. The methodology was presented in the Monument Butte Air Quality Modeling Protocol submitted to and deemed acceptable by the BLM and other air quality stakeholders.

The far-field ambient air quality analysis were performed to quantify the air impacts of the project emissions on Ozone, $PM_{2.5}$, Ambient Air Quality Standards, PSD Increment, Visibility, Deposition, and Acid Neutralization Capacity (ANC)

1.1 Project Description

Newfield Exploration Company (Newfield) has notified the United States (U.S.) BLM VFO of its need to expand their ongoing oil and natural gas development within and in the vicinity of the Greater Monument Butte Unit (GMBU). Newfield has derived a plan that it proposes to implement in order to fulfill its obligations and responsibilities under federal leases to explore, develop, and produce commercial quantities of oil and natural gas. The Monument Butte Project Area (MBPA) is located in southeastern Duchesne County and southwestern Uintah County. The MBPA consists of approximately 119,743 acres located in Township 4 South, Range 1 East; Township 4 South, Range 1-3 West; Township 5 South, Range 1 and 2 East; Township 5 South, Range 3 West; Township 8 South, Range 15-19 East; Township 9 South, Range 15-19 East; and Township 10 South, Range 15-18 East.

Surface ownership in the MBPA is approximately 87 percent federal (managed by the BLM), approximately 11 percent State of Utah (managed by State Institutional Trust Lands Administration [SITLA]), and approximately two percent private. Mineral interests are owned by the BLM (89 percent), the State of Utah (10 percent), and private interests (less than one percent). Lands with separate surface and mineral ownership, also known as “split estate lands,” comprise approximately 18 percent of land within the MBPA. Mineral and surface ownership rights are summarized in Table 1-1.

Table 1-1 : Surface and Oil and Gas Minerals Ownership within the MBPA

Surface Owner	Surface Acres	Surface Percentage	Mineral Acres	Mineral Percentage
BLM	103,891	87	106,562	89
State of Utah	12,878	11	11,983	10
Private	2,974	2	1,198	1
Totals	119,743	100	119,743	100

Federal lands in the MBPA are under the jurisdiction of the BLM VFO. The VFO has determined that implementing the proposed development constitutes a federal action requiring the development of an EIS. The EIS serves the purpose of disclosing and analyzing impacts from the Proposed Action, the No Action alternative, and the other development alternatives.

Newfield's objective is to develop their leases and efficiently produce commercial and economic quantities of oil and gas in the MBPA. Newfield estimates that its plan could yield over 334.9 million barrels of oil (MMBO), 540,669 million cubic feet (MMCF) of natural gas, and 10,085 million barrels (Mbbl) of natural gas liquids (NGLs) from the Green River formation, and 6.9 trillion cubic feet (Tcf) of natural gas from the deep gas development through 2035.

Section 2.2.11 of the Draft EIS commits to performing regional photochemical modeling within one year of the Record of Decision (ROD) for this project or within one year of the BLM Air Resource Management Strategy (ARMS) modeling platform becoming available, whichever occurs first. However, since the ARMS platform became available before the EIS was finalized, it was decided to include the photochemical modeling results in the Final EIS (FEIS).

Specific details on the Proposed Action and other project alternatives are presented in Chapter 2 of the EIS.

The Proposed Action includes the following primary components:

- Development of up to 750 Green River oil wells on 40-acre surface and downhole spacing drilled from new 2-acre well pads, all of which would be converted into waterflood injection wells after approximately 3 years of production;

- Development of up to 2,500 Green River oil wells on 20-acre downhole spacing that would be vertically, directionally, or horizontally drilled from existing and/or proposed 40-acre surface spaced Green River oil well pads, consistent with current State spacing requirements;

- Development of up to 2,500 vertical deep gas wells on 40-acre surface and downhole spacing drilled from new 3-acre well pads, which would be constructed adjacent to Green River oil well pads to reduce new surface disturbance and use existing utility infrastructure and access roads;

- Construction of approximately 243 miles of new 100-foot wide Right Of Way (ROW) that would be used for new road construction (40-foot width) and pipeline installation (60-foot width). Up to 70-foot wide expansion along approximately 363 miles of existing access road ROW that would be used for road upgrade (10-foot width) and pipeline installation (60-foot width);

- Construction of 20 new compressor stations for deep gas well development;
- Expansion of three existing Green River oil well compressor stations and construction of one new compressor station for gas associated with Green River oil well development;
- Construction of a 50 MMscf/d centralized gas processing plant;
- Construction of seven new and expansion of six existing water treatment and injection facilities for management and distribution and injection of produced water;
- Construction of up to 12 Gas Oil Separation Plants (GOSP) for oil and produced water collection;
- Development of one fresh water collector well for waterflood operations; and
- Construction of six water pump stations.

Newfield currently operates approximately 3,395 oil and gas wells in the MBPA and proposes to drill associated wells at an average rate of 360 wells per year until the resource base is fully developed. Under this drilling scenario, construction, drilling, and completion of up to 5,750 wells would occur for approximately 16 years. The total number of wells drilled would depend largely on outside factors such as production success, engineering technology, reservoir characteristics, economic factors, commodity prices, rig availability, and lease stipulations. The anticipated life of an individual well is 20 to 30 years, and the anticipated time it would take for field abandonment and final reclamation is 5 years. Therefore, the anticipated life of project (LOP) under the Proposed Action would be from 41 to 51 years.

The proposed action has the highest emissions of any alternatives considered for all pollutants.

1.2 Modeling Approach

Recent high levels of observed ozone in the Uinta Basin required evaluation of potential ozone impacts due to the MB Project emissions. Ozone is an important component of photochemical smog. Ozone is not emitted directly into the atmosphere, but is formed from photochemical reactions of precursor species in the presence of sunlight. The most important precursors are oxides of nitrogen (NO_X) and volatile organic compounds (VOCs). High ozone episodes occur most typically in urban areas during summer. Under these conditions, there is an abundance of ozone precursors from human activities and the high angle of the summer sun means there is sufficient sunlight available to drive the photochemical reactions which produce ozone. High summer temperatures enhance VOC emissions and speed the chemical reactions which produce ozone from its precursors.

In the last decade, high ozone (i.e. 8-hour average concentration>75 ppb) has been measured during winter in the Uinta Basin as well as Wyoming's Upper Green River Basin (e.g. EDL, 2011; Schnell et al., 2009; Carter and Seinfeld, 2012). The phenomenon of winter high ozone under conditions with low sun angles and cold temperatures was novel, particularly because the Uinta and Upper Green River Basins are relatively rural areas whose main source of ozone precursor emissions is oil and gas exploration and production.

A series of field studies were carried out in the Uinta Basin in order to investigate the mechanisms for ozone formation under winter conditions (e.g. Lyman et al., 2013[1]; ENVIRON, 2014[2]). Data from these studies have been used to identify to key factors that contribute to ozone formation in winter[3] (e.g. Edwards et al. 2014):

- Shallow temperature inversion (limits vertical mixing)
- White snow on ground (highly reflective snow enhances actinic UV flux and facilitates development and maintenance of inversion)
- Few or no clouds
- Stagnant and/or recirculating slow surface winds (limits dispersion of pollutants)
- High precursor concentrations
- High VOC/NO_X ratio

On April 12, 2012, the EPA designated Duchesne and Uintah Counties in the Uinta Basin as unclassifiable, based on high winter ozone readings in previous years. Regulatory ozone monitoring began in the Uinta basin in April 2012. At the time EPA designations were performed, the data record was not long enough to form the three year average needed to calculate a design value for comparison with the NAAQS. In 2013, high values of ozone (8-hour readings in excess of 100 ppb) were monitored in the Uinta Basin. Under the Clean Air Act, the EPA is required to review the NAAQS periodically. On November 26, 2014, the EPA announced their intention to lower the eight-hour ozone

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1http://www.deq.utah.gov/locations/U/uintahbasin/ozone/docs/2014/03Mar/ubos_2011-12_final_report.pdf

2http://www.deq.utah.gov/locations/U/uintahbasin/ozone/docs/2014/06Jun/UBOS2013FinalReport/UBOS_2013Secs_1-2.pdf

3 Edwards, P. et al. 2014. High winter ozone pollution from carbonyl photolysis in an oil and gas basin. *Nature*. 514, 351–354. doi:10.1038/nature13767.

NAAQS to a value in the 65-70 ppb range and to finalize the NAAQS by October, 2015[4]. Continued high ozone in the Uinta Basin and the potential for a more stringent ozone NAAQS in the near future indicate that a future nonattainment designation is a possibility for the Uinta Basin and that an assessment of the ozone impacts of the MB Project emissions is necessary for this air quality impact assessment.

The need to address ozone impacts required the use of a photochemical grid model, which is a type of computer model that simulates the formation, transport, and fate of ozone and other pollutants in the atmosphere. Because photochemical grid models can also be used to model particulates and assess visibility and deposition impacts, the photochemical grid model was also used to perform the MB AQRV impact assessment.

For nearly two decades, EPA has been developing the Models-3 Community Multi-scale Air Quality (CMAQ) modeling system with the overarching aim of producing a 'One-Atmosphere' air quality modeling system capable of addressing ozone, particulate matter (PM), visibility and deposition within a common platform[5,6]. The original justification for the Models-3 development emerged from the challenges posed by the 1990 Clean Air Act Amendments and EPA's desire to develop an advanced modeling framework for 'holistic' environmental modeling utilizing state-of-science representations of atmospheric processes in a high performance computing environment. EPA completed the initial stage of development with Models-3 and released CMAQ in mid-1999 as the initial operating science model under the Models-3 framework. The version of CMAQ that was used in the ARMS study (version 5.0), publicly released February 2012, was used for this study.

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4 https://www.federalregister.gov/articles/2014/12/17/2014-28674/national-ambient-air-quality-standards-for-ozone5 Byun, D.W., and J.K.S. Ching. 1999. *Science Algorithms of the EPA Models-3 Community Multiscale Air Quality (CMAQ) Modeling System*, EPA/600/R-99/030.

5 Byun, D.W., and J.K.S. Ching. 1999. *Science Algorithms of the EPA Models-3 Community Multiscale Air Quality (CMAQ) Modeling System*, EPA/600/R-99/030.

6 Byun, D.W., and K.L. Schere. *2006. Review of the Governing Equations, Computational Algorithms, and Other Components of the Models-3 Community Multiscale Air Quality (CMAQ) Modeling System*, Applied Mechanics Reviews, Vol. 59, pp 51-77.

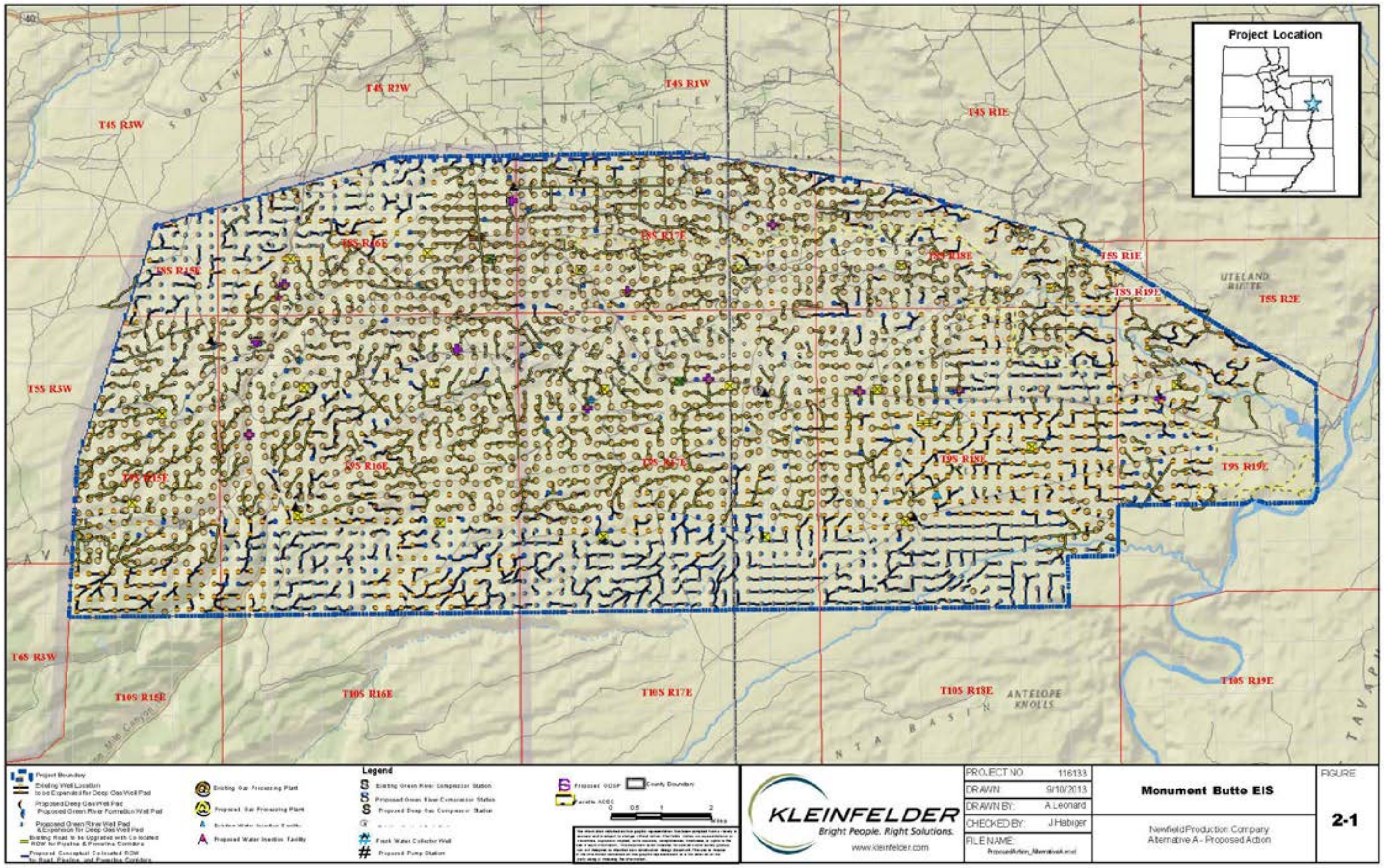

Figure 1-1 Map of Monument Butte Project Area in Uintah and Duchesne Counties, Utah. Figure from BLM (2013).

2 Technical Approach

2.1 Modeling Platform

The CMAQ modeling system was used for assessing the potential far-field impacts of the Monument Butte (MB) project in the surrounding area.

This modeling made use of the Air Resource Management Strategy (ARMS) Modeling Platform. The goal of the ARMS project was to develop a reusable modeling platform for use in National Environmental Policy Act (NEPA) analyses for each proposed project that would occur on BLM-administered federal land. In this section we present a high level overview of the modeling system to help orient the reader. More information is on the ARMS Modeling Project Website[7].

2.1.1 Episode Selection

Calendar year 2010 was chosen for the base modeling period for ARMS.

2.1.2 Horizontal Modeling Domain

Figure 2-1 displays the 36/12/4 km modeling domains that was used in the CMAQ/ Sparse Matrix Operator Kernel Emissions model (SMOKE) air quality/emissions modeling. The 36 km continental United States (U.S.) horizontal domain for CMAQ air quality and SMOKE emissions modeling is identical to what is used by several Regional Planning Organizations (RPOs) for their regional haze modeling (e.g., WRAP, CENRAP and VISTAS). This 36 km modeling domain covers the continental U.S. as well as large portions of Mexico and Canada. The CMAQ 12 km modeling domain, with the 4km modeling domain inset is shown in Figure 2-2 and covers eastern Utah, western Colorado and portions of Wyoming, Arizona and New Mexico. The 4km domain covers all of Utah south of the Great Salt Lake.

These grids are based on a Lambert Conformal Projection (LCP) using the same projection as adopted by the RPOs. The LCP is defined by the projection parameters listed in Table 2-1.

Table 2-2 lists the number of rows and columns and the definition of the X and Y origin (i.e., the southwest corner) for the 36/12/4 km domains to be used by the CMAQ and the SMOKE, models.

7 http://www.blm.gov/ut/st/en/prog/more/air_quality.html

Table 2-1: Lambert Conformal Projection (LCP) Definition for the ARMS Modeling Grid

Parameter	Value
Projection	Lambert-Conformal
1st True Latitude	33 degrees N
2nd True Latitude	45 degrees N
Central Longitude	-97 degrees W
Central Latitude	40 degrees N

Table 2-2: Grid Definitions for SMOKE and CMAQ

Model	Columns	Rows	Xorigin (km)	Yorigin (km)
Emissions/CMAQ				
36 km grid	148	112	-2736.0	-2088.0
12 km grid	111	111	-1872.0	-612.0
4 km grid	144	126	-1500.0	-264.0

2.1.3 Vertical Modeling Structure

The CMAQ vertical structure is primarily defined by the vertical grid used in the Weather Research and Forecasting (WRF) meteorological modeling. The WRF model employs a terrain-following coordinate system defined by pressure, using multiple layers that extend from the surface to 50 mb (approximately 20 km above ground level - AGL). Table 2-3 lists the vertical layer structure. Note that the WRF and CMAQ models both use a terrain following “sigma” coordinate system so over elevated terrain the model heights will be compressed.

2.1.4 Emissions Inventory

The Emissions Inventory for this project is based on the ARMS 2010 and 2021 Modeling Platform. The base year inventory for ARMS was developed using a variety of data inputs sources. Detailed descriptions of the Base and future year development process can be found in the “Utah State BLM Emissions Inventory Technical Support Document” dated November 2013. Table 2-4 presents the summary table of the 2010 base year emissions inventory data sources and Table 2-5 presents the summary table of the future year emissions data sources.

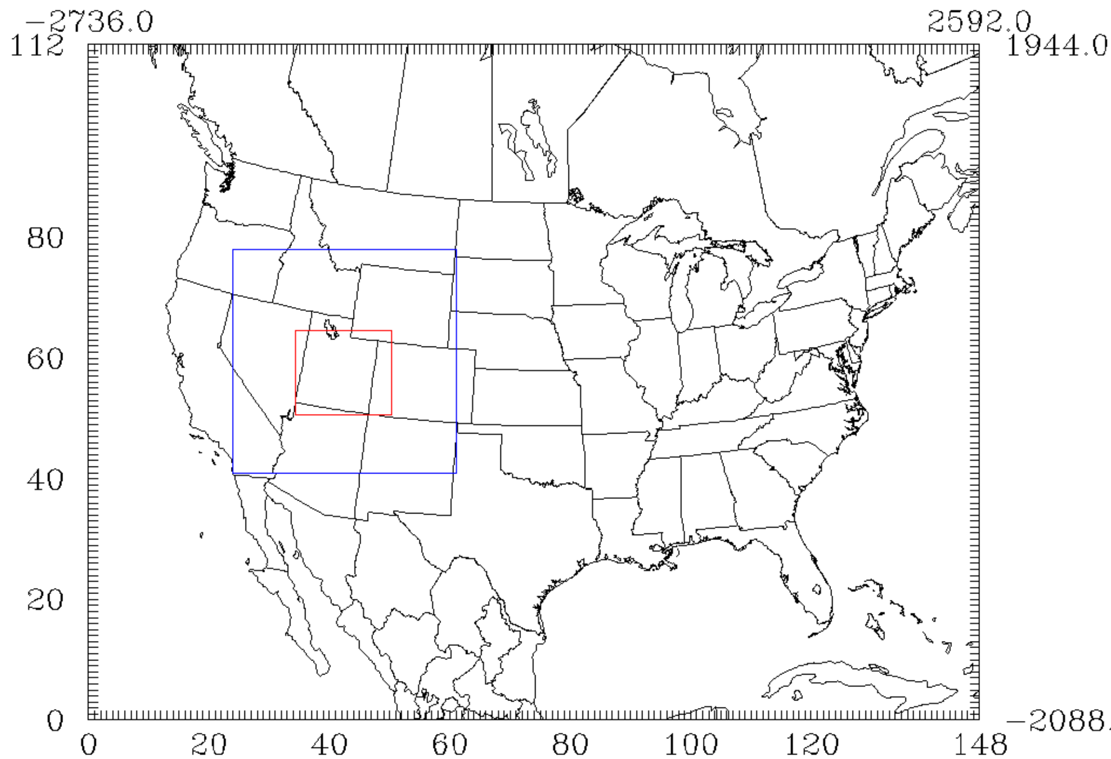

Figure 2-1: 36km, 12km- and 4-km ARMS CMAQ Domains.

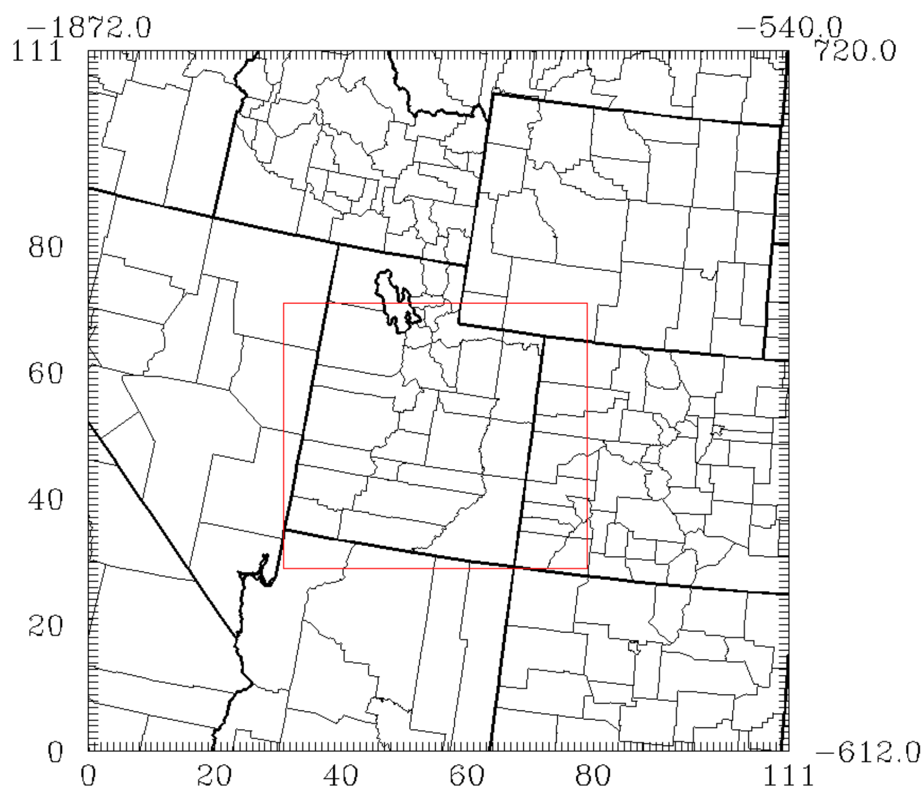

Figure 2-2: 12km and 4km ARMS CMAQ Domain

Table 2-3: Vertical Layer Definition for ARMS CMAQ Simulation.

Layer	Sigma	Pres (mb)	Height (m)	Depth (m)
35 (top)	0.000	50.00	19,260	3,003
34	0.050	97.50	16,257	2,627
33	0.100	145.00	13,360	1,700
32	0.150	192.50	11,930	1,389
31	0.200	240.00	10,541	1,181
30	0.250	287.50	9,360	1,032
29	0.300	335.00	8,328	920
28	0.350	382.50	7,408	832
27	0.400	430.00	6,576	760
26	0.450	477.50	5,816	701
25	0.500	525.00	5,115	652
24	0.550	572.5	4,463	609
23	0.600	620.00	3,854	572
22	0.650	667.50	3,282	540
21	0.700	715.00	2,741	414
20	0.740	753.00	2,329	298
19	0.770	781.50	2,032	290
18	0.800	810.00	1,742	188
17	0.820	829.00	1,554	185
16	0.840	848.00	1,369	182
15	0.860	867.00	1,188	178
14	0.880	886.00	1,009	175
13	0.900	905.00	834	87
12	0.910	914.50	747	85
11	0.920	924.00	662	85
10	0.930	933.50	577	85
9	0.940	943.00	492	83
8	0.950	952.50	409	83
7	0.960	962.00	326	83
6	0.970	971.50	243	81
5	0.980	981.00	162	41
4	0.985	985.75	121	41
3	0.990	990.50	80	40
2	0.995	995.25	40	40
1 (ground)	1.000	1000	0	0

Table 2-4: Base Year ARMS Emissions Inventory Data Sources

Source Group	Spatial Area	Data Source	Method to Project Data to Common Base Year	Additional Controls Applied	Spatial Surrogates
Electric Generating Units (EGU) Point Sources	All Areas except Utah, Colorado, Wyoming, Arizona and New Mexico	2009 USEPA CEMS data for NOx and SO2. Other pollutants estimated as function of heat input.	None	No	NA
	Colorado, Wyoming, Arizona and New Mexico	2010 CEMS data for NOx and SO2. Other pollutants estimated as function of heat input.	NA	No	NA
Non-EGU Point Sources	All Areas except Utah	WRAP 2020 Plan 02d and WRAP 2018 Preliminary Reasonable Progress VerB (PRP18b)	Linear Interpolation	Yes	NA
	Utah	2008 Utah State Annual Emissions Inventory	NA	No	NA
Oil and Gas – Uinta Basin	4-km	WRAP Phase III for 2006	Emissions adjusted to 2010 Levels based on the actual oil and gas well counts and production	Yes	Uinta Basin Oil and Gas Spatial Surrogates
All Other Oil and Gas Basins	All Areas except Uinta Basin	Various	Various	Yes	Spatial surrogates of well locations
All Non-Oil and Gas Area Sources	All Areas except Utah	WRAP 2002 Plan02d to WRAP 2018 PRP18b	Interpolation (technique varies by source type/SCC)	Yes	USEPA defaults for each SCC
	Utah	Utah State Division of Air Quality (UDAQ) 2010 Emissions Inventory Area Sources (UDAQ 2011)	NA	No	USEPA defaults for each SCC
Non-Road Motor Vehicle	All Areas Except Utah	WRAP 2002 Plan02d to WRAP 2018 PRP18b	Interpolation (technique varies by source type/SCC)	Yes	USEPA defaults for each SCC
	Utah	UDAQ 2008 Non-Road	Extrapolation	No	USEPA

Source Group	Spatial Area	Data Source	Method to Project Data to Common Base Year	Additional Controls Applied	Spatial Surrogates
		Emissions Inventory	to 2010 based on Utah-specific projection data (data differs by source type/SCC)		defaults for each SCC
On-Road Motor Vehicle	All Areas Except Utah	Vehicle Miles Traveled (VMT) from 2008 NEI	VMT activity data modeled with Motor Vehicle Emission Simulator (MOVES)	No	Road Link Data
	Utah	UDAQ 2010 VMT and fleet distribution data	VMT activity data modeled with (MOVES)	No	Road Link Data
Road Dust and Fugitive Dust (Excluding Wind Blown Dust)	All Areas Except Utah	WRAP Mobile Source Emissions Inventories Update of the WRAP 2002	None	No	WRAP allocation method
	Utah	UDAQ 2010 Emissions Inventory Area Sources	NA	No	Road Link Data and agricultural land surface data
Ammonia	All	2008 NEI	None	No	USEPA Allocation
Fires	All	Satellite-derived 2010 emissions data from SMARTFIRE	NA	No	NA
Biogenic	All	2001 Land Use data and 2010 Meteorological Data modeled with MEGAN	NA	No	NA
Mexico, Canada and Offshore Sources	36-km	WRAP 2002 Plan 02d	None	No	WRAP allocation Method

Source: Utah State BLM Emissions Inventory Technical Support Document, November, 2013, Table 2-1.

Table 2-5: Future Year ARMS Emissions Inventory Data Sources

Source Groups	Spatial Area	Emissions Inventory for Maximum Emissions Year
Oil and Gas – Uinta Basin	Uinta Basin	Incorporate EIS/EA data and project and extrapolate the 2010 base year
All Other Oil and Gas Basins	United States	Base Year inventories projected to future year, 2021, based on economic activity data
Point Sources (non-oil and gas)	All Areas Except Utah	2020 NEI based on 2005 platform (USEPA 2010)
Point Sources (non-oil and gas)	Utah	2020 NEI based on 2005 platform (USEPA 2010)
Area Sources (non-oil and gas)	All Areas Except Utah	2020 NEI based on 2005 platform (USEPA 2010)
Area Sources (non-oil and gas)	Utah	Methodology consistent with UDAQ
Non-Road Motor Vehicle (non-oil and gas)	All Areas except Utah	2020 NEI based on 2005 platform (USEPA 2010)
Non-Road Motor Vehicle (non-oil and gas)	Utah	2020 NEI based on 2005 platform (USEPA 2010)
On-Road Motor Vehicle	All Areas	2020 NEI based on 2007 platform (USEPA 2012)

Source: Utah State BLM Emissions Inventory Technical Support Document, November, 2013, Table 4-1.

2.2 Project Specific Impact Analysis

This section presents the model input preparation procedures and model output processing procedures used for assessing the project specific impacts

2.2.1 CMAQ Simulations

In order to simulate the far-field impacts for reactive species, it is necessary to develop emissions estimates for all other emission sources (i.e. industrial, electric generation, motor vehicle, biogenic) in addition to the emissions from the MB project.

The foundation datasets for the emissions development was the ARMS future year (2021) On The Books (OTB) simulation. This future year emissions inventory contains an emissions estimate for this project, along with several other projects currently being considered in the Basin. However, the emissions for the MB project as estimated in the ARMS modeling are different than the current emissions estimates for the project due to different emissions calculation methodology, project descriptions and spatial distributions.

It was necessary to reprocess the ARMS future year emissions to remove the ARMS estimated emissions from the project. This simulation is the new future base simulation. It was then necessary to process the most updated project emissions and to merge these emissions into the new future base simulation.

The CMAQ modeling consisted of four different model simulations. Run 1 was the ARMS future year OTB simulation. The output of this simulation was compared with the ARMS model outputs to assure consistent operation of the model between the BLM and Alpine computer system. Run 2 was an updated future year OTB simulation with the emissions modified to remove the ARMS estimated project emissions. This simulation is the new baseline for comparison of the project emissions. The third and fourth simulations are updated future year OTB simulations with two different estimated project emissions included. The project impact is the difference between the new project base and the simulation with the new project base plus project emissions.

Since the project area is well contained within the 4km CMAQ modeling domain, only the 4km domain simulations were performed and analysis restricted to the 4km domain.

2.2.2 Emission Input Processing

The ARMS platform emissions were prepared using the SMOKE 3.1 emissions model. The SMOKE model is used to spatially disaggregate emissions into the proper model grid cell and to apply temporal adjustments and speciate the emissions into the CMAQ specific chemical mechanism (CB05).

The MB project emissions inventory used in the ARMS Future Year (FY) cumulative impact modeling was not the same as project emissions inventory developed as part of the 2013 Draft Enivironmental Impact Statement (DEIS).

In the absence of better information, the ARMS 2021 FY inventory was projected using the assumption that 2,000 new project wells would be developed between the 2010 base year and the 2021 Future Year (FY) The current MB project description calls for 5,750 new wells. To account for these differences it was necessary to remove the ARMS estimated emissions for the project from the ARMS future year cumulative emissions inventory.

2.2.3 ARMS Cumulative Emissions without Project

The document “Utah State BLM Emissions Inventory Technical Support Document, Appendix F- Uinta Basin Oil and Gas Future Year Emissions Projections Supporting Data” contains details about the development of the 2021 future year emissions produced for the ARMs modeling platform.

In the ARMS platform, the Uinta Basin Oil and Gas emissions were divided into area and point sources. The 2021 FY emissions for oil and gas sources was developed by applying growth factors based on SCC codes to the 2010 baseline emissions. These growth factors were calculated based on activity data directly affected by the well counts.

The area source oil and gas categories are emissions that are developed on a county-wide level and then distributed to the modeling grid using a spatial surrogate. In the ARMS platform, this category includes most of the oil and gas specific emissions. The growth methodology used in ARMS includes the application of a county-wide growth factor based on one of six activity surrogates and SCC codes. The Uinta and Duchesne County emissions contained SCC codes that are projected using one of the factors presented in Table 2-6 and Table 2-7, respectively.

Table 2-6: Activity Data Used for Growth Factor Calculations For Uinta County (removing 1464 wells). From Table F-12 ARMS TSD

Uintah County Scaling Ratio Surrogates	Units	2010 Baseline	2021 Projected	2021 with MB Removed	Adjustment Factor
Total Well Count	#Wells	5,252	12,326	10,862	.88
Spud Count	#Spuds	447	1,236	1,044	.84
Total Gas Production	MMscf	282,993,518	892,170,511	786,204,453	.88
Total Condensate Production	bbl	3,011,797	9,103,567	8,022,306	.88
Total Oil Production	bbl	3,598,666	5,918,322	5,215,383	.88

Table 2-7: Activity Data Used for Growth Factor Calculations For Duchesne County (removing 536 wells). From Table F-12 ARMS TSD

Duchesne County Scaling Ratio Surrogates	Units	2010 Baseline	2021 Projected	2021 with MB Removed	Adjustment Factor
Total Well Count	#Wells	1,963	2,374	1,838	.77
Spud Count	#Spuds	422	162	91	.56
Total Gas Production	MMscf	33,035,337	48,912,519	378690986	.77
Total Condensate Production	bbl	369,873	528,644	409,287	.77
Total Oil Production	bbl	10,541,188	9,564,074	7,404704	.77

All of these scaling ratios are based on county total well counts for all operators. The ARMS TSD lists the number of wells, by project, used in the scaling ratio calculations. The scaling ratio for four of these categories (Total Well Count, Gas Production, Oil Production and Condensate Production) were developed based on the additional wells developed between 2010 and 2021. Of these, the MB project was to develop 1,464 wells in Uintah County and 536 wells in Duchesne County. Removing MB well counts results in 10,862 total wells in Uinta County and 1,838 total wells in Duchesne County. The fourth category, Spud Counts, was based on the number of wells drilled in 2021, and removing the estimated number drilled for the MB project reduces the spud count from 1,236 to 1,044 in Uinta County and from 162 to 91 in Duchesne County. To remove the projected MB emissions, the adjustment factors were calculated based on the percentage reduction between the well count with and without the project. Uintah County and Duchesne emissions were adjusted downwards using the adjustment factors presented in Table 2-6 and Table 2-7.

These reduction factors were applied, by SCC codes, to the total Uinta and Duchesne County area source emissions, and the resulting emissions were processed using SMOKE and replaced the ARMS Uinta County area source oil and gas data. The SMOKE processing used the same temporal, spatial and speciation data as used for ARMS.

Point source emissions are geographically located directly to the modeling grid using spatial identifiers. In this application, none of the ARMS point source oil and gas emissions were identified as requiring adjustments to the 2021 estimates. The ARMS 2021 point source oil and gas were used without adjustments. The area emissions as modeled in ARMS, and with the MB project removed are presented in Table 2-8.

Table 2-8: 2021 Emissions totals for Uinta and Duchesne County Oil and Gas (tons/year).

	Uinta Area Sources		Duchesne Area Sources	
	ARMS	With MB Removed	ARMS	With MB Removed
NOx	15,663	13,645	3,703	2,332
VOC	109,831	95,685	17,981	11,325
CO	48,657	42,390	26,343	16,591
PM_{10}	1,545	1,346	228	144
$PM_{2.5}$	1,545	1,346	228	144
SO_2	35	30	7	4

A spatial plot of the ARMS estimated MB low level NOx emissions is presented in Figure 2-3. The ARMS estimated emissions has the MB project emissions spread through much of central Uinta and southern Duchesne Counties.

2.2.4 Project Emissions

The project alternative with the highest emissions was modeled. For all of the action alternatives, the Proposed Action (Alternative A) has the highest emissions rate for all pollutants. The MB project emissions as documented in the DEIS were computed as the maximum rate for all criteria pollutants. For non-reactive pollutant modeling this is a conservative assumption. However, for reactive modeling, particularly for ozone, it may not be conservative to assume all pollutants are being emitted at the maximum rate at the same time.

The VOC emissions are largely related to production emissions and are likely to peak late in the project life. The NOx emissions are related to development and construction and are likely to peak during project development. Since ozone, if formed by the interaction of the NO_x and VOC emissions and fresh NO emissions, react with ambient ozone and locally suppress ozone formation, modeling the ozone at the maximum rates of both emissions may not be conservative.

To address this issue two different model simulations were performed. One project simulation included the peak emissions for all pollutants (Max. Emissions, Max). The other project simulation will not include the emissions from the development of new wells (Post Drilling, Post Drilling). A comparison of the MB emissions is presented in Table 2-9. The first row presents the MB project emissions as calculated in the ARMS project. The second row (MB Max) presents the emissions for the simulation with simultaneous maximum emissions for all pollutants. The third row (MB Post Drill) presents the emissions for the simulation without development emissions included. The MB EIS calculated maximum NO_x emissions are slightly more than twice the ARMS estimates and the MB EIS calculated maximum VOC emissions are approximately half the ARMS estimates.

A spatial plot of the MB proposed action low level NO_x emissions is presented in Figure 2-4. In comparison with the ARM estimated emissions, the proposed action emissions are confined to a much smaller area.

Table 2-9: Monument Butte Proposed Action Project Emissions and ARMS Estimated Criteria Pollutant Emissions (tons per year)

Year	NO_x	VOC	CO	PM_{10}	$PM_{2.5}$	SO_2
ARMS-2021	3389	20801	16109	284	284	7
MB Max	5688	10361	8524	2903	637	14
MB Post Drilling	4892	10313	7823	2876	597	13

The cumulative impacts for all oil and gas activities in the Basin will be taken from the ARMS Impact Assessment Report.

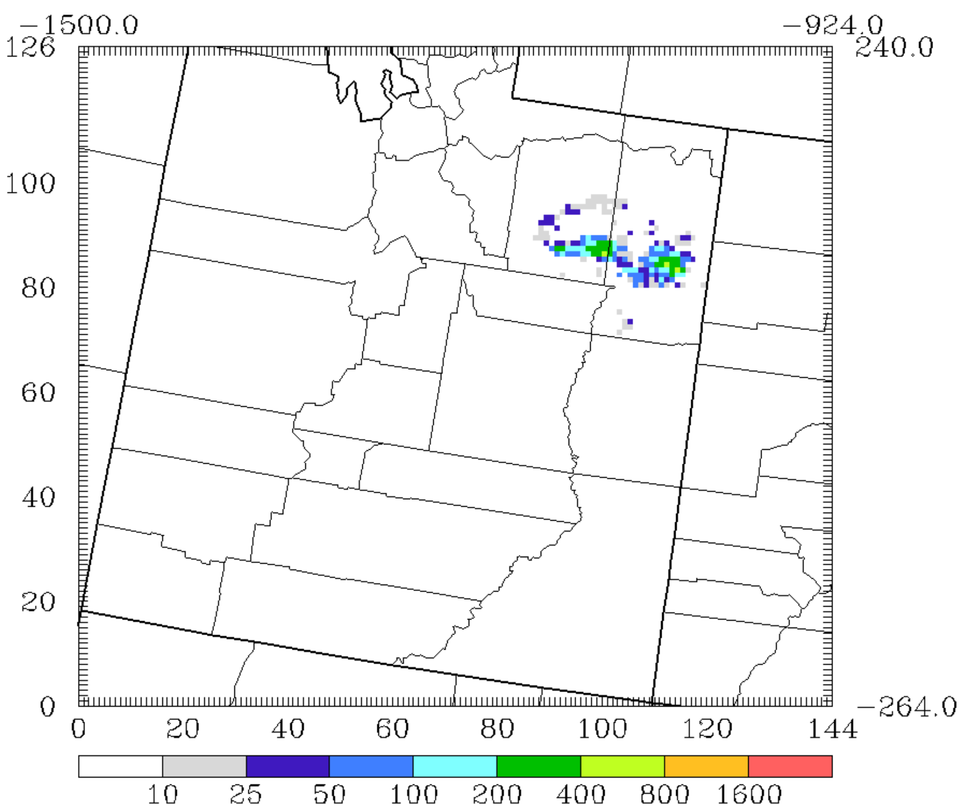

Figure 2-3: ARMS Estimated Monument Butte Low Level NOx emissions (pounds/day).

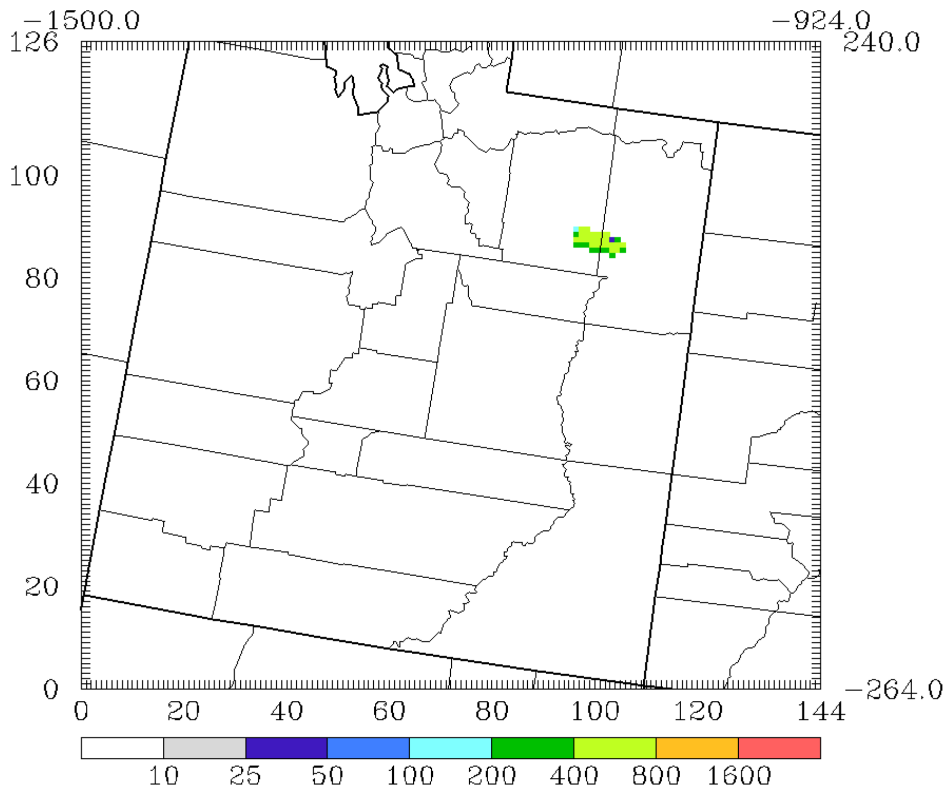

Figure 2-4: Monument Butte Proposed Action Low Level NOx Emissions (pounds/day).

2.2.5 Far Field Impact Assessment Methodology

The project specific impacts were computed using an analogous approach to the analyses in the Utah Air Resource Management Strategy Modeling Project Impact Assessment Report. The specific impacts that were computed are presented in Table 2-10. Air Quality and visibility impacts were reported in the Uintah Basin Study Area, Class 1 areas and Class 2 area regions in Table 2-11. Deposition and Acidification were also reported at the Sensitive Lakes in Table 2-11. The analysis regions are all shown in Figure 2-5.

Table 2-10: Air Quality and Air Quality Related Value Metrics.

Pollutant	Impact Metric
Ozone	4th High Absolute Concentration
	MATS Monitor Specific Analysis
	MATS Unmonitored Area Analysis
$PM_{2.5}$	MATS Daily Analysis
	MATS Annual Analysis
	24-hour Maximum Absolute Concentration
	24-hour 98th Percentile Absolute Concentration
	Annual Absolute Concentration
PM_{10}	24-hour Highest Absolute Concentration
	24-hour 98th Percentile Absolute Concentration
	Annual Absolute Concentration
NO_2	1-hour
	Annual
CO	1-hour
	8-hour
SO_2	1-hour
	3-hour
Visibility	Absolute Number of Days Maximum Incremental Change over 0.5 Δdv
	Absolute Number of Days Maximum Incremental Change over 1.0 Δdv
	Absolute Number of Days 98th Percentile Incremental Change over 0.5 Δdv
	Absolute Number of Days 98th Percentile incremental Change over 1.0 Δdv
	Number of Days the Exceed a threshold % Change in Extinction Relative to Natural Background
Nitrogen Deposition	Annual
Sulfur Deposition	Annual
Acidification	Annual
Nutrient Nitrogen Critical Loads	Deposition Analysis Thresholds (DAT)
Acid Neutralization Capacity (ANC)	Limit of Acceptable Change

Table 2-11: Analysis Regions for AQ and AQRV Calculations.

Station	Description
Uinta Basin Study Area	
UNSA1	Uinta Study Area
DINS1	Dinosaur AQS Station
OURA1	Ouray AQS Station
RANG1	Rangely AQS Station
REDW1	Redwash AQS Station
Class 1 Areas	
ARCH1	Arches NP
BRCA1	Bryce Canyon NP
CANY1	Canyonlands NP
CAPI1	Capitol Reef NP
MEVE1	Mesa Verde NP
Class 2 Areas	
DINO1	Dinosaur NM
FLGO1	Flaming Gorge National Recreation Area
GOIR1	Goshute Indian Reservation
HUIN1	High Uintas Wilderness
PAIR1	Paiute Indian Reservation
SVIR1	Skull Valley Indian Reservation
UOIR1	Uintah and Ouray Indian Reservation
Sensitive Lakes	
HEART	Heart Lake, High Uintas WA
4D239	4D2-039,High Uintas WA
DEANL	Dean Lake, High Uintas WA
WALKU	Walk Up Lake, Ashley National Forest
4D144	4D1-044, High Uintas WA
FISHL	Fish Lake, High Uintas WA

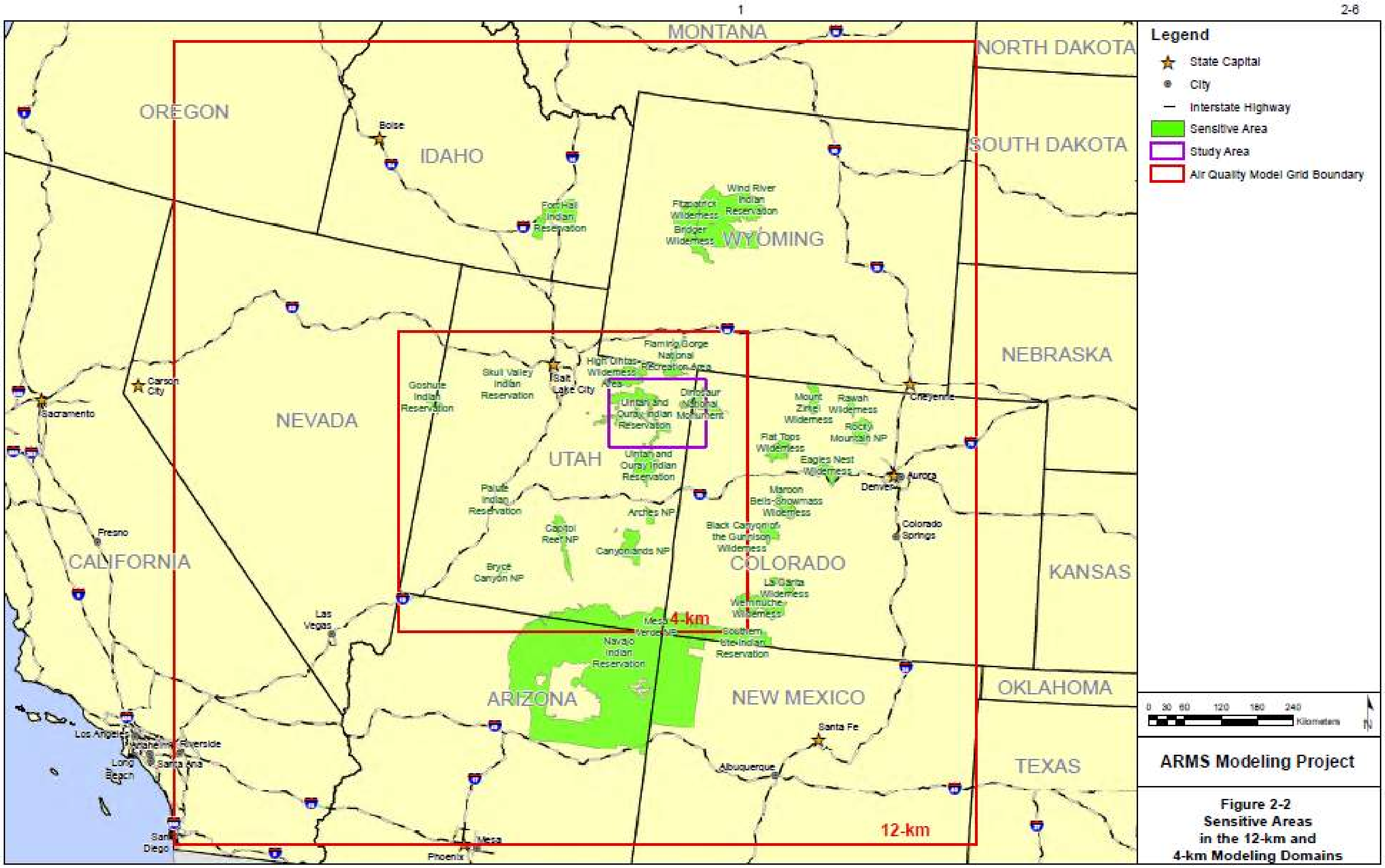

Figure 2-5: Sensitive Areas in the 12km and 4km Modeling Domains.

3 Results

3.1 Ambient Air Quality Impacts

To quantify the impact of the MB project on ambient air quality the air quality modeling results are compared with applicable standards and thresholds. Model predicted concentrations of NO_2, CO, SO_2, ozone, $PM_{2.5}$ and PM_{10} are evaluated at the same assessment area as the ARMS cumulative modeling. The following air quality assessments are presented in this section:

- Comparison of modeled cumulative air quality impacts to the applicable state Ambient Air Quality Standards (AAQS) and National Air Quality Standards (NAAQS)
- Comparison of model adjusted ozone and $PM_{2.5}$ impacts using EPA guidance adjustment techniques
- Comparison of project modeled project air quality impacts to the applicable Prevention of Significant Deterioration (PSD) increments. While the impacts are numerically compared to PSD increments, there is no formal assessment of increment consuming sources.

The modeled concentrations of criteria pollutants at selected assessment areas were compared with applicable NAAQS and State AAQS shown in Table 3-1.

3.1.1 Absolute Air Quality Impacts

Model predicted NO_2 results for the 1-hour average 98th percentile of daily maximum concentrations and the annual average are presented in Table 3-2. For all areas and averaging times the model results including the project emissions are simulated to be less than the applicable NAAQS and State AAQS of 100 ppb for the 1 hour average and 53 ppb for the annual average. Additionally, the project impacts for both the Maximum Emissions Case (Max) and Post Drilling Case (Post Drill) are simulated to be below the SIL levels. Even in the Uinta Basin study area, the project impact on the 98th percentile daily maximum 1-hour average concentration is 2.7 ppb and the project impact on the annual average concentration is 1.1 ppb, less than the most stringent Class 1 PSD increment of 1.3 ppb.

Model predicted CO results for the 1-hour and 8-hour maximum concentrations are presented in Table 3-3. The cumulative impacts of the project and future base emissions are predicted to be much less than the applicable NAAQS and state AAQS levels of 35 ppm for the 1-hour average and 9 ppm for the 8-hour average. The peak 1-hour impact is predicted at the Uintah and Ouray Indian Reservation at 2.8 ppm and the peak 8-hour impact is predicted within the Uinta Basin study and Uinah and Ouray Indian Reservation areas at 1.1 ppb. There is no applicable PSD increment analysis for comparison of project impacts, but project contributions are all predicted to be below 0.1 ppm.

Model predicted SO_2 results for the 1-hour and 3-hour average NAAQS and State AAQS comparison are presented in Table 3-4. In all regions, for all averaging periods the model estimates are well below the standards both with and without the project emissions with the peak 1-hour 99th percentile of 11.3 ppb, much less than the 75 ppb standard and maximum 3-hour value of 21.4 ppb, much less than the 500 ppb standard. The peak 3-hour average project impact is less than 0.1 ppb at all locations, much less than the most stringent Class 1 PSD increment of 9.5 ppb. Model predicted SO_2 results for the 24-hour and annual averages for comparison with the PSD increment are presented in Table 3-5. The 24-hour average maximum project impacts for both cases are less than 0.1, well less than the 24-hour Class 1 increment value of 1.9 ppb. The peak annual average impact is less than 0.1 ppb at all locations, less than the Class 1 PSD increment value of 0.76 ppb.

Model predicted ozone results for the fourth highest 8-hour daily maximum concentration are presented in Table 3-6. The model is estimating concentrations above the 75ppb ozone standard in the Uinta Study area and at the Uintah and Ouray Indian Reservation. However it is important to note that the ozone standard is the three-year average of the fourth highest daily maximum 8-hour average so the modeled value does not necessary indicate a violationof the standard. No PSD increment value or other significance criteria has been established for ozone. The peak impact is estimated at 1.6 ppb at the Dinosaur AQS station. In all Class 1 areas the model is estimating project impacts 0.1 ppb or less. Spatial plots of the 99th percentile (4th high) daily maximum 8-hour ozone concentrations for the future base, max emissions, and post drill cases are presented in Figures 3-1 though 3-3, respectively. The model estimates the highest ozone concentrations in the Salt Lake City area, with a secondary high ozone area in the Uintah Basin. Differences between the 99th percentile concentrations with the Maximum emissions case and the future base are shown in Figure 3-4 and the analogous difference for the Post Drilling case are presented in Figure 3-5. For both simulations the area of impact is primarily in the Uintah Basin with areas of ozone decrease (due to NO_x titration) near the project areas and higher ozone concentration away from the project area.

Model predicted $PM_{2.5}$ concentrations are presented in Table 3-7. The future base and project simulations 24-hour average 98th percentile values are less than the NAAQS and State AAQS values of 35 ug/m^3 for all simulations and locations except for the Maximum emissions case in the Uintah Study Area where the standard is exceeded by 0.5 ug/m^3. The model estimated Maximum emissions contribution is 48% direct $PM_{2.5}$, 29% nitrate, 11% ammonium, 8% sulfate, 3% organic carbon and 1% elemental carbon The annual averages are less than the annual average NAAQS and State AAQS primary standard of 12 ug/m^3. The project impacts do not exeeed the PSD increments for the 24-hour average maximum or annual average. For the 24-hour average 98th percentile the project impacts exceed the more stringent Class 1 area PSD increment of 2 ug/m^3, but not the Class 2 area PSD inrement of 9 ug/m^3 in the Uinta Study Area, the Ouray AQS Station and the Uintah and Ouray Indian Reservation. Spatial plots of the model estimated 98th percentile (8th high) 24-hour average PM2.5 concentrations for the future base, maximum emissions case and post drill cases are presented in Figures 3-6 thgouh 3-8, respectively. The model is estimating high concentrations primarily in the Salt Lake City area and in the Uintah Basin. Differences between the 98th percentile concentrations with the Maximum emissions case and the future base are shown in Figure 3-9 and the analogous difference for the Post Drilling case are presented in Figure 3-10. The maximum difference is near the project area with the concentrations decreasing away from the project area.

Model predicted 24-hour average PM_{10} concentrations for comparison with the NAAQS, State AAQS and PSD increment are presented in Table 3-8. The 24-hour maximum and the 24-hour 99th percentile values are less than the NAAQS and State AAQS values with or without the project emissions. The project contributions on 24-hour average 98th percentile values are less than the PSD increment values for all regions except the Unita Study Area for the Max. emissions case where impacts exceed the Class 1 PSD Increment value, but is less than the Class 2 PSD Increment value. The annual average PM_{10} concentrations for comparison with the PSD increment are presented in Table 3-9. The project contributions are all less than the PSD increment.

In summary, all project contributions are less that the Class 2 PSD increment values even in the Uintah Study area and the only model estimated values in excess of either the NAAQS or State AAQS is the 4th high daily maximum 8-hour average ozone concentrations in the Uinta Basin Study Area and in the Uintah and Ouray Indian Reservation and the Maximum emissions case in the Uintah Study area where the 98th percentile $PM_{2.5}$ concentration standard of 35 ug/m^3 is exceeded by 0.5 ug/m^3.

3.1.2 Model Adjusted Air Quality Impacts

EPA guidance for the use of photochemical models for assessing attainment of the ozone and $PM_{2.5}$ NAAQS call for model results to be used in a relative sense[8] (EPA, 2007).

The ozone NAAQS are formulated in terms of a Design Value, which is calculated as the 3-year average of the fourth highest monitored daily maximum 8-hour concentration at each monitoring site. To attain the 2008 ozone standard, the Design Value for a given monitor must not exceed 75 ppb. EPA's latest modeling guidance (EPA, 2007) for projecting future year 8-hour ozone Design Values recommends the use of modeling results in a relative sense to scale the observed current year 8-hour ozone Design Value (DVC) to obtain a future year 8-hour ozone Design Value (DVF). The model-derived scaling factors are referred to as Relative Response Factors (RRF) and are defined as the ratio of daily maximum 8-hour ozone concentrations near a monitor averaged over several days of modeling results for the future year emissions scenario to the current year base case:

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8 EPA, 2007. "Guidance on The Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze", EPA-454/B-07-002. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. April. (262 pgs.)

$$RRF_{monitor\ \ i} = \frac{\sum_{days}(daily\ \max 8 - hour\ ozone)_{future\ \ year}}{\sum_{days}(daily\ \max 8 - hour\ ozone)_{current\ \ year}}$$

$$DVF_{monitor\ i} = DVC_{monitor\ i} \times RRF_{monitor\ i}$$

This technique is used to minimize the effect of model uncertainty on future year ozone projections. For example, if the model has a bias toward underestimating ozone at a given monitor, using the raw future year ozone predictions may result in an underestimate of future year ozone at that monitor. However, if the ratio of the future year to base year modeled ozone values at that monitor is multiplied by the observed base year design value to produce a predicted future year value, that future year value will better reflect the change in ozone due to changes in emissions between base and future year cases, and the effect of the model's bias toward lower ozone values will have been reduced.

The EPA have developed a software tool called the Model Attainment Test Software (MATS[9]). The MATS tool was employed using the same options as in the ARMS impact modeling.

The MATS monitor specific ozone analysis is presented in Table 3-10. The model is predicting concentrations in excess of the 75 ppb NAAQS and State AAQS at the Ouray Site, Cottonwood Site, and Hawthorne Sites. The project is estimated to have less than 0.1 ppb impact at the Cottonwood and Hawthorne sites which are located well outside the Uinta Basin in Salt Lake County. The maximum project impact at the Ouray site is a 0.5 ppb contribution for the Post Drilling case. The peak impact at any monitor is 1.5 ppb at the Fruitland Site (AIRS: 490131001). The MATS unmonitored area ozone results are presented in Table 3-11. The peak impact is 1.4 ppb in the Uintah and Ouray Indian Reservation. Spatial plots of the MATS unmonitored area ozone result future design values are presented in Figures 3-11 though 3-13 for the future base, maximum project and post drilling cases, respectively. For all simulations the analysis shows an area of exceedance of the ozone standard of 75 ppb to the west of the project area in western Uintah County. Difference plots between the MATS unmonitored results for the maximum emissions case and the future base case are presented in Figure 3-14. As with the absolute model results (Figure 3-4), the analysis is showing an ozone decrease near the project area with concentration increases in Duchesne and Uintah Counties away from the project area. Analogous results for the post drilling case are presented in Figure 3-15. For the post drilling case the ozone decrease in the project area is lower, since the project has less NOx emissions and the ozone concentration increases away from the project area are lower than with the maximum emissions case.

The MATS monitored area daily $PM_{2.5}$ results are presented in Table 3-12. The only monitor estimated to be over the 35 ug/m^3 NAAQS and State AAQS standard is the Cottonwood site in

9 http://www.epa.gov/scram001/modelingapps_mats.htm

Salt Lake County, Utah. This monitor is located near Salt Lake City, well away from the project area. In all cases the project impacts are less than 0.1 ug/m^3 at this site. The peak project impacts are 0.1 ug/m^3 or less at all monitors. The MATS monitored area annual $PM_{2.5}$ results are presented in Table 3-13. All monitors are simulated to be below the NAAQS and State AAQS standards and the project contributions are less than 0.1 ug/m^3 at all monitors, less than the Class 1 PSD increment value of 1 ug/m^3.

The MATS unmonitored area annual $PM_{2.5}$ results are presented in Table 3-14. All areas are estimated to be below the NAAQS and State AAQS except for the Unita Study Area and the Uintah and Ouray Indian Reservation where the primary NAAQS of 12 ug/m^3 is exceeded but the secondary NAAQS of 15 ug/m^3 is not exceeded. The peak project contribution is estimated to be at the Uinta Study Area with a 0.4 ug/m^3 contribution, less than the Class 1 PSD increment value of 1 ug/m^3.

Table 3-1: Applicable Ambient Air Quality Standards

Pollutant (units)	Averaging Period	AAQS[1]			PSD Increments[17]	
		National[2]	Utah[3]	Colorado[4]	Class 1	Class 2
NO_2 (ppb)	1-hour	100[12]	100[12]	100[12]	--	--
	Annual[5]	53	53	53	1.3	13.3
CO (ppm)	1-hour[6]	35	35	35	--	--
	8-hour[6]	9	9	9	--	--
SO_2 (ppb)	1-hour	85[13]	75[13]	75[13]	--	--
	3-hour[6]	500	500	500	9.5	195.5
	24-hour[7]	--	--	--	1.9[6]	34.8[6]
	Annual	--	--	--	0.76[5]	7.6[5]
Ozone (ppb)	1-hour[8]	--	--	--	--	--
	8-hour[9]	75	75	75	--	--
$PM_{2.5}$ (ug/m3)	24-hour[10]	35	35	35	2[6]	9[6]
	Annual[5]	12[14]	12[14]	12[14]	1	4
	Annual[5]	15[15]	15[15]	15[15]	1	4
PM_{10} (ug/m3)	24-hour[11]	150	150	150	8[6]	30[6]
	Annual[5]	--[16]	--[16]	--[16]	4	17

Table from ARMS Impact Report

1 Due to the lack of an identified regional issue for lead, it was not analyzed as part of this study.
2 Source: http://www.epa.gov/air/criteria.html#3.
3 Source: http://www.deq.utah.gov/locations/uintahbasin/docs/2013/09Sep/NatAmbAirQualStand.pdf.
4 Source: http://www.colorado.gov/airquality/permits/guide.pdf.
5 Not to be exceeded.
6 Not to be exceeded more than once per year.
7 Final rule signed June 2, 2010. The 24-hour and annual SO2 standards from 1971 were revoked in that same rulemaking. However, these standards remain in effect until 1 year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.
8 The USEPA revoked the 1-hour ozone standard in all areas, although some areas have continuing obligations under thatstandard. The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.
9 To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. A new 8-hour ozone standard is anticipated to be finalized by the USEPA in late 2015.
10 24-hour average of the 98th percentile concentrations (effective December 17, 2006).
11 Not to be exceeded more than once per year on average over 3 years.
12 The 3-year average of the 98th percentile of the daily maximum 1-hour average is not to exceed this standard.
13 The 3-year average of the 99th percentile of the daily maximum 1-hour average is not to exceed this standard.
14 Primary standard, annual mean, averaged over 3 years.
15 Secondary standard, annual mean, averaged over 3 years.
16 The annual PM10 NAAQS of 50 µg/m3 was revoked by the USEPA on September 21, 2006; see Federal Register, volume 71, number 200, 10/17/06.
17 Source: 40 Code of Federal Regulations Part 52, Section 21, as amended by the Final Rule in Federal Register, volume 70, number 59582, 10/12/05 and Federal Register, volume 75, number 64863, 10/20/10.

Table 3-2: Model Predicted Ambient Air Quality Impacts for NO_2 (ppb) for MB Future Year, Max. Emissions and Post Drilling Proposed Action.

Receptor Site	1-hr 98th Percentile Daily Max					Annual				
	Future Base	Max	Project Impact	Post Drill	Project Impact	Future Base	Max	Project Impact	Post Drill	Project Impact
Uinta Basin Study Area										
Uinta Study Area	89.0	89.6	0.6	89.4	0.4	28.7	28.9	0.2	28.8	0.2
Dinosaur AQS Station	8.8	10.5	1.6	10.4	1.6	0.9	0.9	0.1	0.9	0.0
Ouray AQS Station	52.5	55.1	2.7	54.0	1.5	9.9	10.9	1.0	10.7	0.9
Rangely AQS Station	10.1	10.4	0.4	10.4	0.3	1.6	1.6	0.0	1.6	0.0
Redwash AQS Station	43.0	43.7	0.7	43.7	0.7	6.7	6.8	0.1	6.8	0.1
Class 1 Areas										
Arches NP	2.7	2.7	0.0	2.7	0.0	0.5	0.5	0.0	0.5	0.0
Bryce Canyon NP	2.4	2.4	0.0	2.4	0.0	0.2	0.2	0.0	0.2	0.0
Canyonlands NP	3.9	3.9	0.0	3.9	0.0	0.3	0.3	0.0	0.3	0.0
Capitol Reef NP	4.2	4.2	0.0	4.2	0.0	0.3	0.3	0.0	0.3	0.0
Mesa Verde NP	9.7	9.7	0.0	9.7	0.0	0.6	0.6	0.0	0.6	0.0
Class 2 Areas										
Dinosaur NM	8.8	10.5	1.6	10.4	1.6	0.9	0.9	0.1	0.9	0.0
Flaming Gorge National Recreation Area	21.1	21.1	0.0	21.1	0.0	2.8	2.8	0.0	2.8	0.0
Goshute Indian Reservation	0.7	0.7	0.0	0.7	0.0	0.1	0.1	0.0	0.1	0.0
High Uintas Wilderness	2.0	2.0	0.0	2.0	0.0	0.2	0.2	0.0	0.2	0.0
Paiute Indian Reservation	14.0	14.0	0.0	14.0	0.0	1.0	1.0	0.0	1.0	0.0
Skull Valley Indian Reservation	6.8	6.8	0.0	6.8	0.0	0.4	0.4	0.0	0.4	0.0
Uintah and Ouray Indian Reservation	88.6	89.6	1.0	89.4	0.8	28.7	28.9	0.2	28.8	0.2

Table 3-3: Model Predicted Ambient Air Quality Impacts for CO (ppm) for MB Future Base, Max. Emissions and Post Drilling Proposed Action.

Receptor Site	1-hr Average Maximum					8-hr Average Maximum				
	Future Base	Max	Project Impact	Post Drill	Project Impact	Future Base	Max	Project Impact	Post Drill	Project Impact
Uinta Basin Study Area										
Uinta Study Area	1.4	1.4	0.0	1.4	0.0	1.1	1.1	0.0	1.1	0.0
Dinosaur AQS Station	0.5	0.5	0.0	0.5	0.0	0.2	0.2	0.0	0.2	0.0
Ouray AQS Station	0.8	0.8	0.0	0.8	0.0	0.5	0.5	0.0	0.5	0.0
Rangely AQS Station	0.2	0.2	0.0	0.2	0.0	0.2	0.2	0.0	0.2	0.0
Redwash AQS Station	0.4	0.4	0.0	0.4	0.0	0.2	0.3	0.0	0.2	0.0
Class 1 Areas										
Arches NP	0.5	0.5	0.0	0.5	0.0	0.4	0.4	0.0	0.4	0.0
Bryce Canyon NP	0.3	0.3	0.0	0.3	0.0	0.2	0.2	0.0	0.2	0.0
Canyonlands NP	0.2	0.2	0.0	0.2	0.0	0.2	0.2	0.0	0.2	0.0
Capitol Reef NP	0.2	0.2	0.0	0.2	0.0	0.1	0.1	0.0	0.1	0.0
Mesa Verde NP	0.4	0.4	0.0	0.4	0.0	0.2	0.2	0.0	0.2	0.0
Class 2 Areas										
Dinosaur NM	0.5	0.5	0.0	0.5	0.0	0.2	0.2	0.0	0.2	0.0
Flaming Gorge National Recreation Area	0.6	0.6	0.0	0.6	0.0	0.4	0.4	0.0	0.4	0.0
Goshute Indian Reservation	0.2	0.2	0.0	0.2	0.0	0.1	0.1	0.0	0.1	0.0
High Uintas Wilderness	0.3	0.3	0.0	0.3	0.0	0.2	0.2	0.0	0.2	0.0
Paiute Indian Reservation	0.6	0.6	0.0	0.6	0.0	0.4	0.4	0.0	0.4	0.0
Skull Valley Indian Reservation	0.2	0.2	0.0	0.2	0.0	0.2	0.2	0.0	0.2	0.0
Uintah and Ouray Indian Reservation	2.8	2.8	0.0	2.8	0.0	1.1	1.1	0.0	1.1	0.0

Table 3-4: Model Predicted Ambient Air Quality Impacts for SO_2 (ppb) for MB Future Base, Max. Emissions and Post Drilling

Receptor Site	1-hr Average 99th Percentile					3-hr Average Maximum				
	Future Base	Max	Project Impact	Post Drill	Project Impact	Future Base	Max	Project Impact	Post Drill	Project Impact
Uinta Basin Study Area										
Uinta Study Area	7.1	7.1	0.0	7.1	0.0	9.6	9.6	0.0	9.6	0.0
Dinosaur AQS Station	1.4	1.4	0.0	1.4	0.0	1.6	1.6	0.0	1.6	0.0
Ouray AQS Station	0.8	0.8	0.0	0.8	0.0	0.8	0.8	0.0	0.8	0.0
Rangely AQS Station	1.1	1.1	0.0	1.1	0.0	1.3	1.3	0.0	1.3	0.0
Redwash AQS Station	2.0	2.0	0.0	2.0	0.0	2.6	2.6	0.0	2.6	0.0
Class 1 Areas										
Arches NP	0.8	0.8	0.0	0.8	0.0	1.0	1.0	0.0	1.0	0.0
Bryce Canyon NP	0.7	0.7	0.0	0.7	0.0	0.8	0.8	0.0	0.8	0.0
Canyonlands NP	1.8	1.8	0.0	1.8	0.0	3.5	3.5	0.0	3.5	0.0
Capitol Reef NP	1.8	1.8	0.0	1.8	0.0	2.1	2.1	0.0	2.1	0.0
Mesa Verde NP	2.8	2.8	0.0	2.8	0.0	3.2	3.2	0.0	3.2	0.0
Class 2 Areas										
Dinosaur NM	1.4	1.4	0.0	1.4	0.0	1.6	1.6	0.0	1.6	0.0
Flaming Gorge National Recreation Area	11.3	11.3	0.0	11.3	0.0	21.4	21.4	0.0	21.4	0.0
Goshute Indian Reservation	0.5	0.5	0.0	0.5	0.0	0.6	0.6	0.0	0.6	0.0
High Uintas Wilderness	1.5	1.5	0.0	1.5	0.0	2.1	2.1	0.0	2.1	0.0
Paiute Indian Reservation	1.5	1.5	0.0	1.5	0.0	2.2	2.2	0.0	2.2	0.0
Skull Valley Indian Reservation	1.7	1.7	0.0	1.7	0.0	2.0	2.0	0.0	2.0	0.0
Uintah and Ouray Indian Reservation	9.1	9.1	0.0	9.1	0.0	9.7	9.7	0.0	9.7	0.0

Table 3-5: Model Predicted PSD Increment Analysis for SO_2 (ppb) for MB Future Base, Max. Emissions and Post Drilling Proposed Action.

Receptor Site	24-hr Average Maximum					Annual Average Maximum				
	Future Base	Max	Project Impact	Post Drill	Project Impact	Future Base	Max	Project Impact	Post Drill	Project Impact
Uinta Basin Study Area										
Uinta Study Area	4.2	4.2	0.0	4.2	0.0	0.5	0.5	0.0	0.5	0.0
Dinosaur AQS Station	0.7	0.7	0.0	0.7	0.0	0.2	0.2	0.0	0.2	0.0
Ouray AQS Station	0.5	0.5	0.0	0.5	0.0	0.1	0.1	0.0	0.1	0.0
Rangely AQS Station	0.6	0.6	0.0	0.6	0.0	0.1	0.1	0.0	0.1	0.0
Redwash AQS Station	1.2	1.2	0.0	1.2	0.0	0.2	0.2	0.0	0.2	0.0
Class 1 Areas										
Arches NP	0.5	0.5	0.0	0.5	0.0	0.1	0.1	0.0	0.1	0.0
Bryce Canyon NP	0.6	0.6	0.0	0.6	0.0	0.1	0.1	0.0	0.1	0.0
Canyonlands NP	1.0	1.0	0.0	1.0	0.0	0.1	0.1	0.0	0.1	0.0
Capitol Reef NP	0.7	0.7	0.0	0.7	0.0	0.1	0.1	0.0	0.1	0.0
Mesa Verde NP	1.0	1.0	0.0	1.0	0.0	0.2	0.2	0.0	0.2	0.0
Class 2 Areas										
Dinosaur NM	0.7	0.7	0.0	0.7	0.0	0.2	0.2	0.0	0.2	0.0
Flaming Gorge National Recreation Area	6.1	6.1	0.0	6.1	0.0	0.7	0.7	0.0	0.7	0.0
Goshute Indian Reservation	0.3	0.3	0.0	0.3	0.0	0.1	0.1	0.0	0.1	0.0
High Uintas Wilderness	0.7	0.7	0.0	0.7	0.0	0.1	0.1	0.0	0.1	0.0
Paiute Indian Reservation	0.6	0.6	0.0	0.6	0.0	0.1	0.1	0.0	0.1	0.0
Skull Valley Indian Reservation	0.7	0.7	0.0	0.7	0.0	0.1	0.1	0.0	0.1	0.0
Uintah and Ouray Indian Reservation	4.7	4.7	0.0	4.7	0.0	0.7	0.7	0.0	0.7	0.0

Table 3-6: Model Predicted Ambient Air Quality Impacts for Ozone (ppb) for MB Future Base, Max. Emissions and Post Drilling Proposed Action.

Receptor Site	8-hr Average 99th Percentile Daily Max.				
	Future Base	Max	Project Impact	Post Drill	Project Impact
Uinta Basin Study Area					
Uinta Study Area	**88.0**	**88.5**	0.5	**88.5**	0.5
Dinosaur AQS Station	73.1	74.6	1.6	74.4	1.4
Ouray AQS Station	75.1	75.5	0.4	75.5	0.4
Rangely AQS Station	70.5	70.5	0.0	70.5	0.0
Redwash AQS Station	71.3	71.6	0.3	71.6	0.3
Class 1 Areas					
Arches NP	69.5	69.6	0.1	69.5	0.1
Bryce Canyon NP	70.2	70.2	0.0	70.2	0.0
Canyonlands NP	69.8	69.9	0.1	69.9	0.0
Capitol Reef NP	71.1	71.1	0.0	71.1	0.0
Mesa Verde NP	69.3	69.3	0.0	69.3	0.0
Class 2 Areas					
Dinosaur NM	73.1	74.6	1.6	74.4	1.4
Flaming Gorge National Recreation Area	68.9	69.9	1.0	69.7	0.8
Goshute Indian Reservation	69.5	69.5	0.0	69.5	0.0
High Uintas Wilderness	70.0	70.0	0.0	70.0	0.0
Paiute Indian Reservation	70.6	70.6	0.0	70.6	0.0
Skull Valley Indian Reservation	69.4	69.4	0.0	69.4	0.0
Uintah and Ouray Indian Reservation	**82.4**	**83.2**	0.8	**83.5**	1.1

Highlighted values denote values in excess of the State AAQS and NAAQS of 0.075 ppm.

Table 3-7: Model Predicted Ambient Air Quality Impacts for $PM_{2.5}$ (ug/m^3) for MB Future Base, Max. Emissions and Post Drilling Proposed Action.

Receptor Site	24-hr Average Maximum					24-hr Average 98th Percentile					Annual Average				
	Future Base	Max	Project Impact	Post Drill	Project Impact	Future Base	Max	Project Impact	Post Drill	Project Impact	Future Base	Max	Project Impact	Post Drill	Project Impact
Uinta Basin Study Area															
Uinta Study Area	42.7	44.8	2.0	44.6	1.8	28.6	**35.5**	**7.0**	34.7	**6.2**	11.3	11.4	0.1	11.4	0.1
Dinosaur AQS Station	20.0	21.4	1.5	21.2	1.3	13.3	15.1	1.9	14.8	1.5	3.5	3.8	0.3	3.8	0.2
Ouray AQS Station	30.7	32.8	2.1	32.5	1.8	25.2	27.5	2.3	27.5	2.3	6.9	7.4	0.5	7.4	0.5
Rangely AQS Station	10.4	10.6	0.2	10.6	0.2	6.7	6.7	0.1	6.7	0.1	2.5	2.5	0.0	2.5	0.0
Redwash AQS Station	19.5	21.5	2.0	21.3	1.8	13.0	14.3	1.4	14.1	1.2	4.2	4.3	0.1	4.3	0.1
Class 1 Areas															
Arches NP	10.5	10.5	0.0	10.5	0.0	6.0	6.1	0.1	6.1	0.1	2.8	2.8	0.0	2.8	0.0
Bryce Canyon NP	12.0	12.0	0.0	12.0	0.0	4.7	4.7	0.0	4.7	0.0	2.1	2.1	0.0	2.1	0.0
Canyonlands NP	10.1	10.1	0.0	10.1	0.0	6.4	6.5	0.1	6.4	0.1	2.2	2.2	0.0	2.2	0.0
Capitol Reef NP	14.6	14.6	0.0	14.6	0.0	6.9	6.9	0.0	6.9	0.0	2.2	2.2	0.0	2.2	0.0
Mesa Verde NP	6.3	6.3	0.0	6.3	0.0	3.9	4.0	0.1	4.0	0.0	1.8	1.8	0.0	1.8	0.0
Class 2 Areas															
Dinosaur NM	20.0	21.4	1.5	21.2	1.3	13.3	15.1	1.9	14.8	1.5	3.5	3.8	0.3	3.8	0.2
Flaming Gorge National Recreation Area	21.1	21.2	0.1	21.2	0.1	11.7	11.9	0.1	11.9	0.1	3.1	3.2	0.0	3.2	0.0
Goshute Indian Reservation	5.3	5.3	0.0	5.3	0.0	3.4	3.4	0.0	3.4	0.0	1.4	1.4	0.0	1.4	0.0
High Uintas Wilderness	7.6	8.2	0.7	8.1	0.5	5.2	5.8	0.6	5.8	0.5	2.1	2.1	0.0	2.1	0.0
Paiute Indian Reservation	11.8	11.8	0.0	11.8	0.0	6.4	6.4	0.0	6.4	0.0	2.7	2.7	0.0	2.7	0.0
Skull Valley Indian Reservation	12.3	12.3	0.0	12.3	0.0	7.3	7.3	0.0	7.3	0.0	2.1	2.1	0.0	2.1	0.0
Uintah and Ouray Indian Reservation	48.0	48.0	0.0	48.0	0.0	28.6	32.4	**3.8**	31.7	3.2	11.3	11.4	0.1	11.4	0.1

Highlighted values exceed the NAAQS or exceed the Class 1 PSD increment value of 2 ug/m^3 but are less than the Class 2 PSD increment value of 9 ug/m^3.

Table 3-8: Model Predicted Ambient Air Quality Impacts for PM_{10} (ug/m^3) for MB Future Base, Max Emissions and Post Drilling Proposed Action.

Receptor Site	24-hr Average Maximum					24-hr Average 99th Percentile					24-hr Average 98th Percentile				
	Future Base	Max	Project Impact	Post Drill	Project Impact	Future Base	Max	Project Impact	Post Drill	Project Impact	Future Base	Max	Project Impact	Post Drill	Project Impact
Uinta Basin Study Area															
Uinta Study Area	43.1	48.5	5.4	48.3	5.2	35.4	40.8	5.5	40.1	4.8	29.9	38.2	**8.3**	37.4	7.5
Dinosaur AQS Station	20.4	21.8	1.5	21.7	1.3	16.7	18.0	1.2	17.8	1.1	13.7	15.7	1.9	15.3	1.6
Ouray AQS Station	31.1	33.4	2.3	33.1	2.0	28.2	30.3	2.1	30.3	2.1	25.7	27.8	2.1	27.8	2.1
Rangely AQS Station	11.4	11.6	0.2	11.6	0.2	8.4	8.4	0.0	8.4	0.0	7.7	7.7	0.1	7.7	0.1
Redwash AQS Station	19.8	21.9	2.0	21.6	1.8	16.6	17.8	1.2	17.6	1.0	13.7	14.8	1.1	14.5	0.8
Class 1 Areas															
Arches NP	10.7	10.7	0.0	10.7	0.0	8.4	8.4	0.0	8.4	0.0	7.7	7.7	0.0	7.7	0.0
Bryce Canyon NP	15.8	15.8	0.0	15.8	0.0	7.1	7.1	0.0	7.1	0.0	6.7	6.7	0.0	6.7	0.0
Canyonlands NP	10.4	10.4	0.0	10.4	0.0	8.3	8.3	0.0	8.3	0.0	7.0	7.0	0.0	7.0	0.0
Capitol Reef NP	15.0	15.0	0.0	15.0	0.0	8.6	8.6	0.0	8.6	0.0	7.4	7.4	0.0	7.4	0.0
Mesa Verde NP	8.6	8.6	0.0	8.6	0.0	5.8	5.8	0.0	5.8	0.0	4.9	4.9	0.0	4.9	0.0
Class 2 Areas															
Dinosaur NM	20.4	21.8	1.5	21.7	1.3	16.7	18.0	1.2	17.8	1.1	13.7	15.7	1.9	15.3	1.6
Flaming Gorge National Recreation Area	21.8	21.9	0.1	21.9	0.1	16.3	16.5	0.2	16.5	0.2	12.3	12.4	0.1	12.4	0.1
Goshute Indian Reservation	11.5	11.5	0.0	11.5	0.0	8.3	8.3	0.0	8.3	0.0	6.9	6.9	0.0	6.9	0.0
High Uintas Wilderness	11.6	11.6	0.0	11.6	0.0	6.8	7.0	0.2	6.9	0.1	6.2	6.7	0.4	6.6	0.4
Paiute Indian Reservation	14.7	14.7	0.0	14.7	0.0	11.3	11.3	0.0	11.3	0.0	9.6	9.6	0.0	9.6	0.0
Skull Valley Indian Reservation	12.8	12.8	0.0	12.8	0.0	10.0	10.0	0.0	10.0	0.0	8.2	8.2	0.0	8.2	0.0
Uintah and Ouray Indian Reservation	53.3	53.3	0.0	53.3	0.0	32.4	37.4	5.0	36.8	4.4	28.9	34.1	5.2	33.6	4.7

Highlighted values exceed the Class 1 PSD increment value of 8 ug/m^3 but are less than the Class 2 PSD increment value of 30 ug/m^3.

Table 3-9: Model Predicted PSD Increment Analysis for PM_{10} (ug/m^3) for MB Future Base, Max. Emissions and Post Drilling Proposed Action.

Receptor Site	Annual Average				
	Future Base	Max	Project Impact	Post Drill	Project Impact
Uinta Basin Study Area					
Uinta Study Area	14.0	14.3	0.3	14.2	0.3
Dinosaur AQS Station	4.0	4.3	0.2	4.3	0.2
Ouray AQS Station	7.3	7.9	0.6	7.9	0.5
Rangely AQS Station	3.1	3.2	0.0	3.2	0.0
Redwash AQS Station	4.6	4.8	0.2	4.7	0.1
Class 1 Areas					
Arches NP	4.2	4.2	0.0	4.2	0.0
Bryce Canyon NP	2.7	2.7	0.0	2.7	0.0
Canyonlands NP	2.7	2.7	0.0	2.7	0.0
Capitol Reef NP	2.7	2.7	0.0	2.7	0.0
Mesa Verde NP	2.3	2.3	0.0	2.3	0.0
Class 2 Areas					
Dinosaur NM	4.0	4.3	0.2	4.3	0.2
Flaming Gorge National Recreation Area	5.5	5.5	0.0	5.5	0.0
Goshute Indian Reservation	2.0	2.0	0.0	2.0	0.0
High Uintas Wilderness	2.5	2.5	0.0	2.5	0.0
Paiute Indian Reservation	4.1	4.1	0.0	4.1	0.0
Skull Valley Indian Reservation	2.6	2.6	0.0	2.6	0.0
Uintah and Ouray Indian Reservation	11.6	11.8	0.2	11.8	0.2

Table 3-10: MATS Estimated Ozone Impacts (ppb) at Monitored Locations within the 4km Domain.

Station Name	Site ID	Observed Baseline Monitor Design Value	2021 Future Base Design Value	2021 Future Design Value with Max Project Emissions	Impact of Maximum Project Emissions	2021 Future Design Value with Post Drilling Project Emissions	Impact of Post Drilling Project Emissions
Uinta Basin Study Area							
Dinosaur NM, Uintah County, Utah	490471002	71.7	68.1	69.5	1.4	69.3	1.2
Ouray Site, Uintah County, Utah	490472003	97.7	**78.3**	**78.7**	0.4	**78.8**	0.5
Rangely Site, Rio Blanco County, Colorado	81030006	64.0	61.4	61.9	0.5	61.9	0.5
Red Wash Site, Uintah County, Utah	490472002	86.0	72.3	73.6	1.3	73.5	1.2
Utah Stations Outside of Uinta Basin Study Area							
Bountiful Site, Davis County, Utah	490110004	71.3	72.4	72.4	0.0	72.4	0.0
Canyonlands NP Site, San Juan County, Utah	490370101	69.0	66.2	66.2	0.0	66.2	0.0
Cottonwood Site, Salt Lake County, Utah	490350003	75.0	82.8	82.8	0.0	82.8	0.0
Escalante Site, Garfield County, Utah	490170004	53.0	50.7	50.8	0.1	50.8	0.1
Fruitland Site, Duchesne County, Utah	490131001	67.0	61.0	62.5	1.5	62.5	1.5
Harrisville Site, Weber County, Utah	490571003	73.3	70.2	70.2	0.0	70.2	0.0
Hawthorne Site, Salt Lake County, Utah	490353006	75.3	**81.1**	**81.1**	0.0	**81.1**	0.0
Highland Site, Utah County, Utah	490495008	67.5	67.6	67.6	0.0	67.6	0.0
Lakepoint Site, Salt Lake County, Utah	490352004	74.0	69.1	69.1	0.0	69.1	0.0
North Provo Site, Utah County, Utah	490490002	69.0	67.7	67.7	0.0	67.7	0.0
Ogden Site, Weber County, Utah	490570002	72.0	70.8	70.8	0.0	70.8	0.0
Price Site, Carbon County, Utah	490071003	70.0	65.2	65.3	0.1	65.3	0.1
Spanish Fork Site, Utah County, Utah	490495010	69.3	68.2	68.2	0.0	68.2	0.0
St. George Site, Washington County, Utah	490530006	67.3	62.6	62.6	0.0	62.6	0.0
Tooele Site, Tooele County, Utah	490450003	72.3	65.5	65.5	0.0	65.5	0.0

Station Name	Site ID	Observed Baseline Monitor Design Value	2021 Future Base Design Value	2021 Future Design Value with Max Project Emissions	Impact of Maximum Project Emissions	2021 Future Design Value with Post Drilling Project Emissions	Impact of Post Drilling Project Emissions
Zion NP Site, Washington County, Utah	490530130	71.0	64.7	64.7	0.0	64.7	0.0
Colorado							
Cortez Site, Montezuma County, Colorado	80830006	66.0	61.1	61.1	0.0	61.1	0.0
Grand Junction Site, Mesa County, Colorado	80771001	64.7	60.9	61.0	0.1	61.0	0.1
Mesa Verde NP Site, Montezuma County, Colorado	80830101	68.0	62.8	62.8	0.0	62.8	0.0
Wyoming							
Evanston Site, Uinta County, Wyoming	560410101	60.7	54.9	54.9	0.0	54.9	0.0
Wamsutter Southeast Site, Sweetwater County	560370200	64.0	60.1	60.2	0.1	60.2	0.1

Table 3-11: MATS Estimated Ozone Impacts (ppb) at Unmonitored Locations within the 4km Domain.

Receptor Site	MATS Unmonitored				
	Future Base	Max	Project Impact	Post Drill	Project Impact
Uinta Basin Study Area					
Uinta Study Area	82.1	82.4	0.3	82.5	0.4
Class 1 Areas					
Arches NP	65.2	65.3	0.1	65.3	0.1
Bryce Canyon NP	59.1	59.1	0.0	59.1	0.0
Canyonlands NP	66.2	66.3	0.1	66.3	0.1
Capitol Reef NP	61.3	61.3	0.0	61.3	0.0
Mesa Verde NP	62.7	62.7	0.0	62.7	0.0
Class 2 Areas					
Dinosaur NM	70.6	71.1	0.5	71.1	0.5
Flaming Gorge National Recreation Area	57.4	57.5	0.1	57.5	0.1
Goshute Indian Reservation	62.6	62.6	0.0	62.6	0.0
High Uintas Wilderness	61.8	61.8	0.0	61.8	0.0
Paiute Indian Reservation	66.3	66.3	0.0	66.3	0.0
Skull Valley Indian Reservation	61.5	61.5	0.0	61.5	0.0
Uintah and Ouray Indian Reservation	78.0	79.4	1.4	79.4	1.4

Table 3-12: MATS Estimated Daily $PM_{2.5}$ Impacts (ug/m^3) at Monitored Locations within the 4km Domain.

Station Name	Site ID	Observed Baseline Monitor Design Value	2021 Future Base Design Value	2021 Future Design Value with Max Project Emissions	Impact of Max Emissions Project Emissions	2021 Future Design Value with Post Drilling Project Emissions	Impact of Post Drilling Project Emissions
Bountiful Site, Davis County, Utah	490110004	37.4	32.3	32.3	0.0	32.3	0.0
Cottonwood Site, Salt Lake County, Utah	490350003	45.4	**39.3**	**39.3**	0.0	**39.3**	0.0
Harrisville Site, Weber County, Utah	490571003	35.1	27.1	27.1	0.0	27.1	0.0
Highland Site, Utah County, Utah	490495008	31.7	25.3	25.3	0.0	25.3	0.0
Lindon Site, Utah County, Utah	490494001	37.9	30.9	31.0	0.1	31.0	0.1
Magna Salt Lake City Site, Salt Lake County, Utah	490351001	32.4	27.4	27.5	0.1	27.4	0.0
Ogden Site, Weber County, Utah	490570002	38.4	31.0	31.1	0.1	31.1	0.1
Provo Site, Utah County, Utah	490490002	33.3	26.1	26.1	0.0	26.1	0.0
Rose Park Salt Lake Site, Salt Lake County, Utah	490353010	39.0	33.0	33.1	0.1	33.1	0.1
Spanish Fork Site, Utah County, Utah	490495010	38.5	30.6	30.7	0.1	30.6	0.0
Tooele Site, Tooele County, Utah	490450003	25.4	22.0	22.1	0.1	22.1	0.1

Highlighted values denote values in excess of the NAAQS and State AAQS of 35 ug/m^3.

Table 3-13: MATS Estimated Annual $PM_{2.5}$ Impacts (ug/m^3) at Monitored Locations within the 4km Domain.

Station Name	Site ID	Observed Baseline Monitor Design Value	2021 Future Base Design Value	2021 Future Design Value with Max Project Emissions	Impact of Max Project Emissions	2021 Future Design Value with No Development Project Emissions	Impact of Post Drilling Project Emissions
Bountiful Site, Davis County, Utah	490110004	10.2	9.5	9.5	0.0	9.5	0.0
Cottonwood Site, Salt Lake County, Utah	490350003	11.1	10.4	10.4	0.0	10.4	0.0
Harrisville Site, Weber County, Utah	490571003	8.9	8.0	8.0	0.0	8.0	0.0
Highland Site, Utah County, Utah	490495008	8.5	7.6	7.6	0.0	7.6	0.0
Lindon Site, Utah County, Utah	490494001	10.3	9.2	9.2	0.0	9.2	0.0
Magna Salt Lake City Site, Salt Lake County, Utah	490351001	8.6	8.3	8.3	0.0	8.3	0.0
Ogden Site, Weber County, Utah	490570002	10.3	9.3	9.3	0.0	9.3	0.0
Provo Site, Utah County, Utah	490490002	9.9	8.8	8.8	0.0	8.8	0.0
Rose Park Salt Lake Site, Salt Lake County, Utah	490353010	10.4	9.8	9.8	0.0	9.8	0.0
Spanish Fork Site, Utah County, Utah	490495010	9.1	8.0	8.0	0.0	8.0	0.0
Tooele Site, Tooele County, Utah	490450003	6.8	6.9	6.9	0.0	6.9	0.0

Table 3-14: MATS Estimated Annual $PM_{2.5}$ Impacts (ug/m^3) at Unmonitored Locations within the 4km Domain.

Receptor Site	MATS Unmonitored				
	Future Base	Max	Project Impact	Post Drill	Project Impact
Uinta Basin Study Area					
Uinta Study Area	**14.4**	**14.7**	0.4	**14.7**	0.3
Class 1 Areas					
Arches NP	3.9	3.9	0.0	3.9	0.0
Bryce Canyon NP	2.7	2.7	0.0	2.7	0.0
Canyonlands NP	2.8	2.8	0.0	2.8	0.0
Capitol Reef NP	3.0	3.0	0.0	3.0	0.0
Mesa Verde NP	3.7	3.7	0.0	3.7	0.0
Class 2 Areas					
Dinosaur NM	5.1	5.3	0.2	5.3	0.2
Flaming Gorge National Recreation Area	7.1	7.1	0.0	7.1	0.0
Goshute Indian Reservation	2.9	2.9	0.0	2.9	0.0
High Uintas Wilderness	3.9	3.9	0.0	3.9	0.0
Paiute Indian Reservation	5.8	5.8	0.0	5.8	0.0
Skull Valley Indian Reservation	3.1	3.1	0.0	3.1	0.0
Uintah and Ouray Indian Reservation	**14.4**	**14.6**	0.2	**14.5**	0.2

Highlighted values denote values in excess of the NAAQS and State AAQS of 12 ug/m^3.

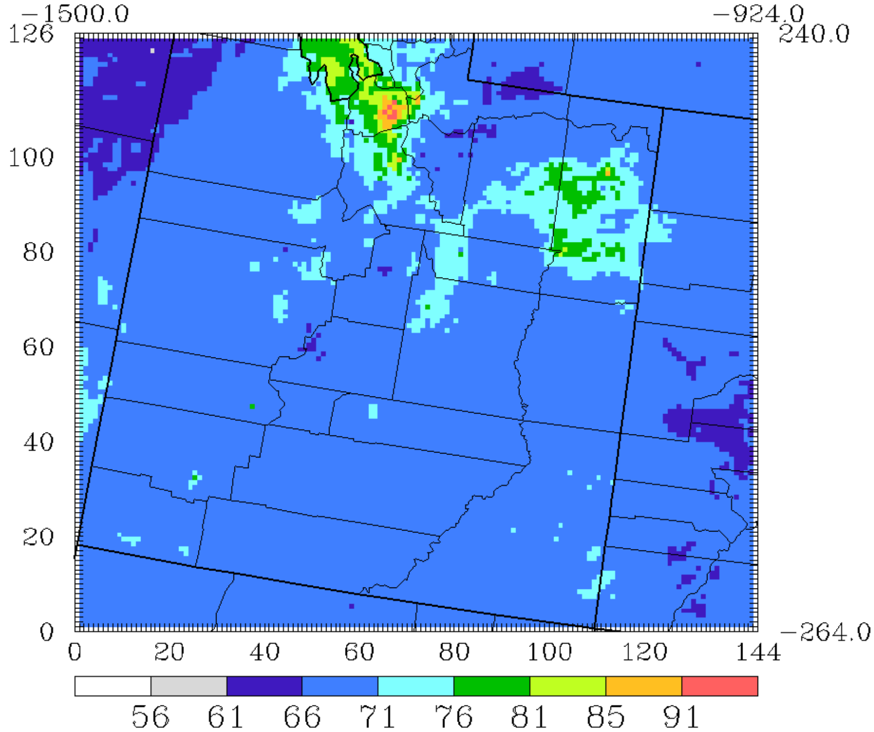

Figure 3-1: 99th Percentile (4th high) Daily Maximum 8-hour Average Ozone Concentration (ppb) for Future Base Simulation.

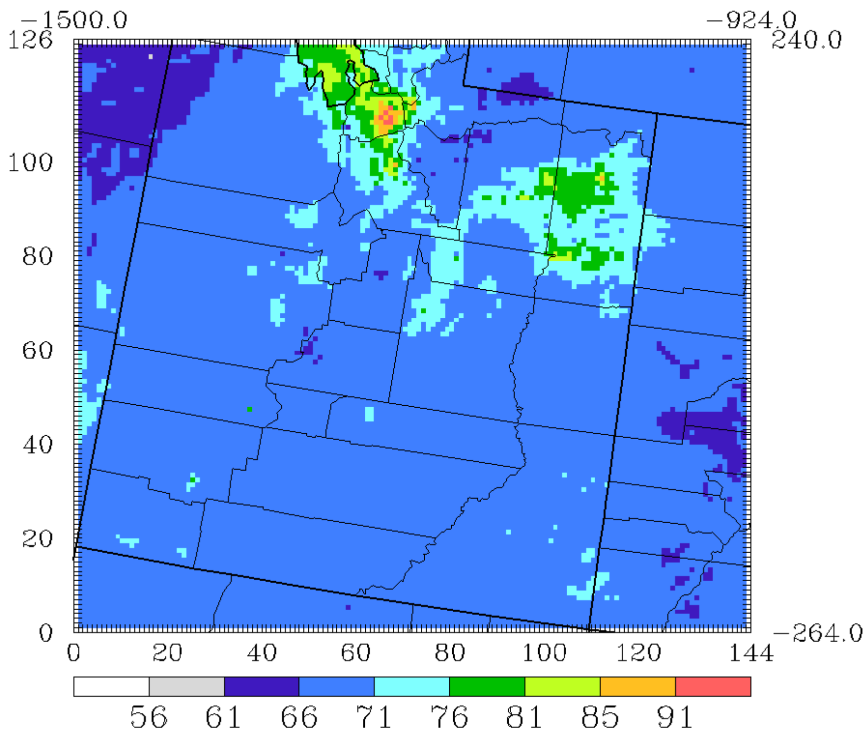

Figure 3-2: 99th Percentile (4th high) Daily Maximum 8-hour Average Ozone Concentration (ppb) for Maximum Emissions Case Simulation.

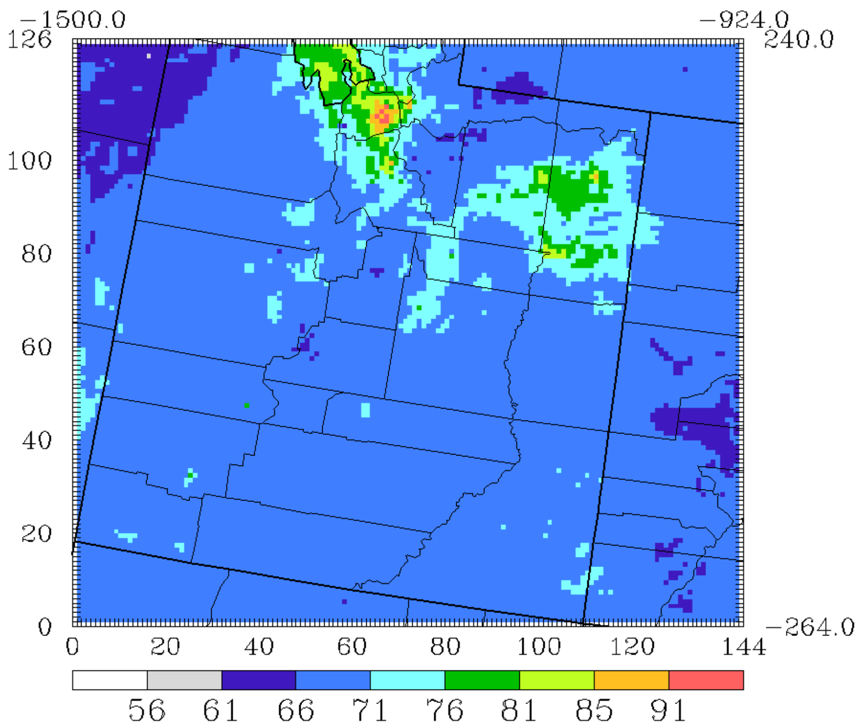

Figure 3-3: 99th Percentile (4th high) Daily Maximum 8-hour Average Ozone Concentration (ppb) for Post Drilling Case Simulation.

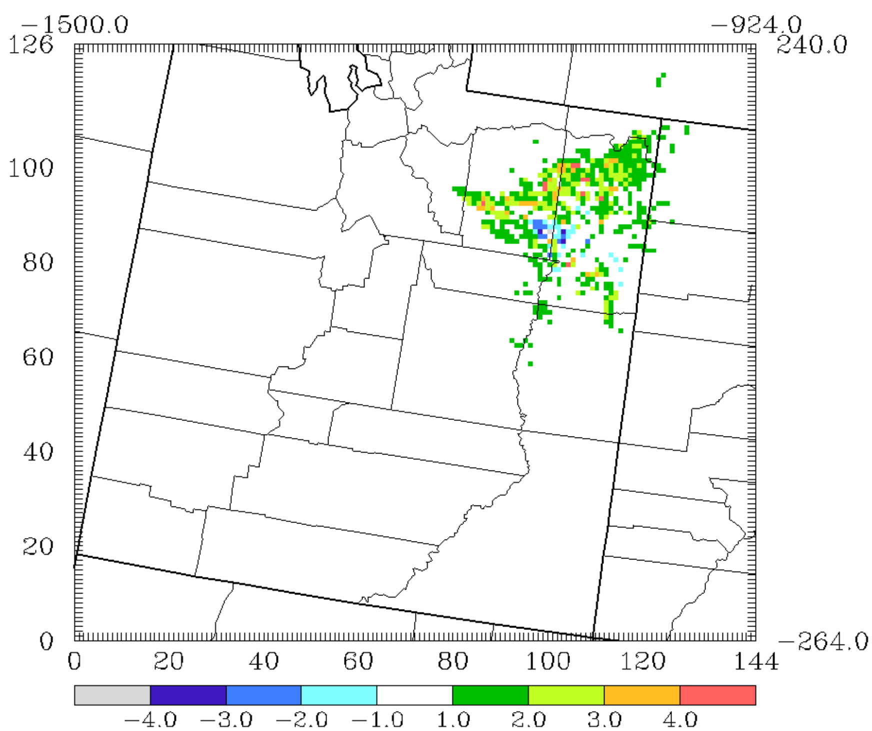

Figure 3-4: Difference in 99th Percentile (4th high) Daily Maximum 8-hour Average Ozone Concentration (ppb) between Future Base Base Simulation and Maximum Emissions Case Simulations.

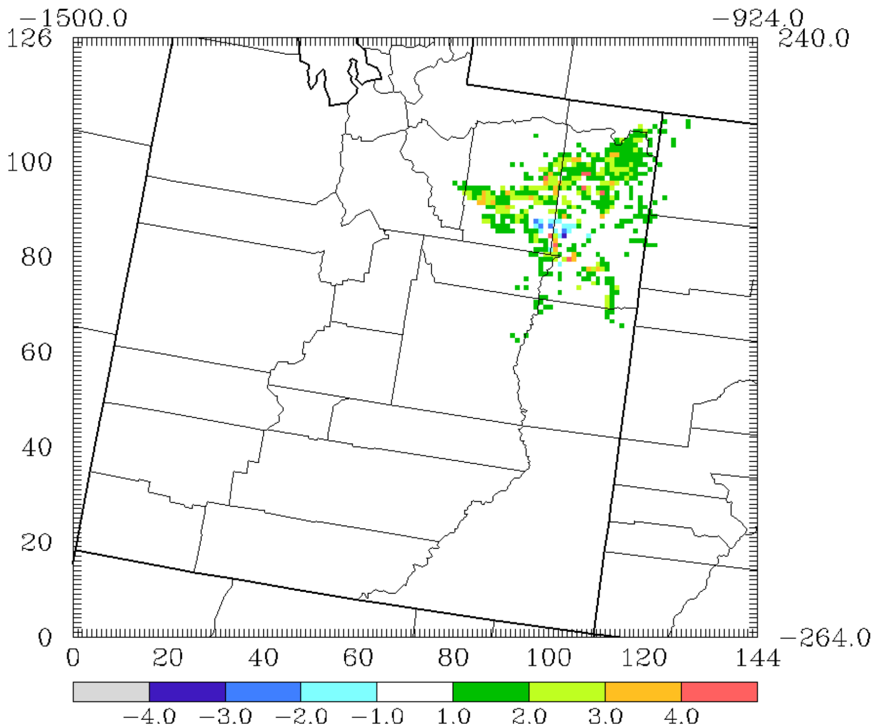

Figure 3-5: Difference in 99th Percentile (4th high) Daily Maximum 8-hour Average Ozone Concentration (ppb) between Future Base Base Simulation and Post Drilling Emissions Case Simulations.

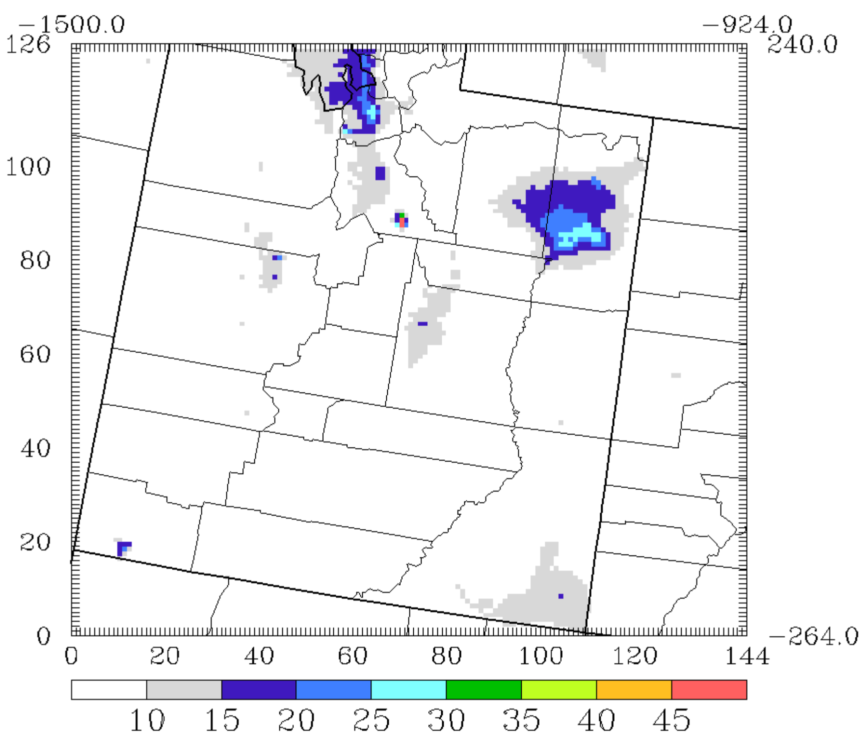

Figure 3-6: 98th Percentile (8th high) 24-hour Average $PM_{2.5}$ Concentration (ug/m^3) for Future Base Simulation.

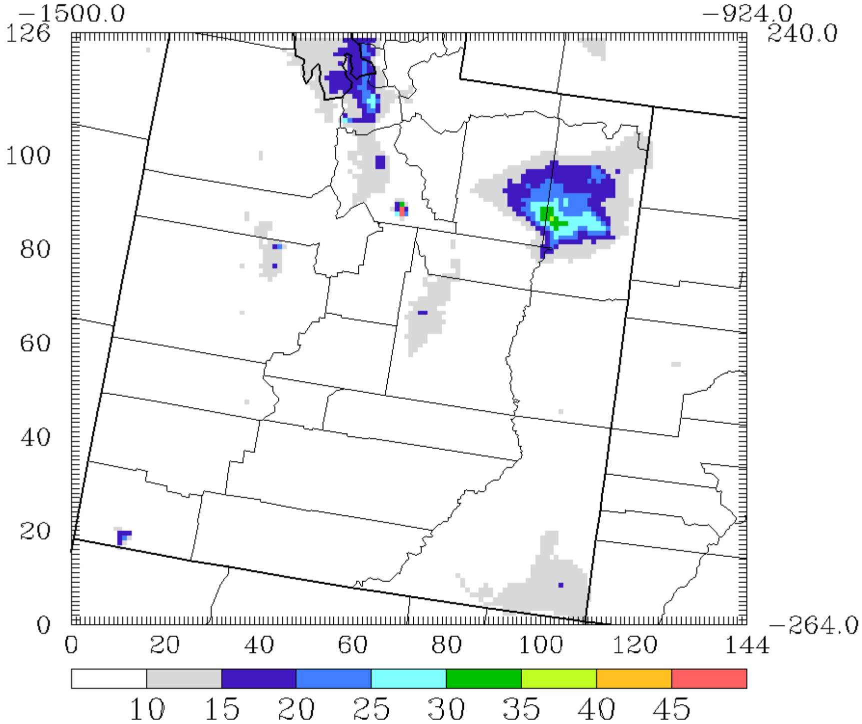

Figure 3-7: 98th Percentile (8th high) 24-hour Average $PM_{2.5}$ Concentration (ug/m^3) for Maximum Emissions Case Simulation.

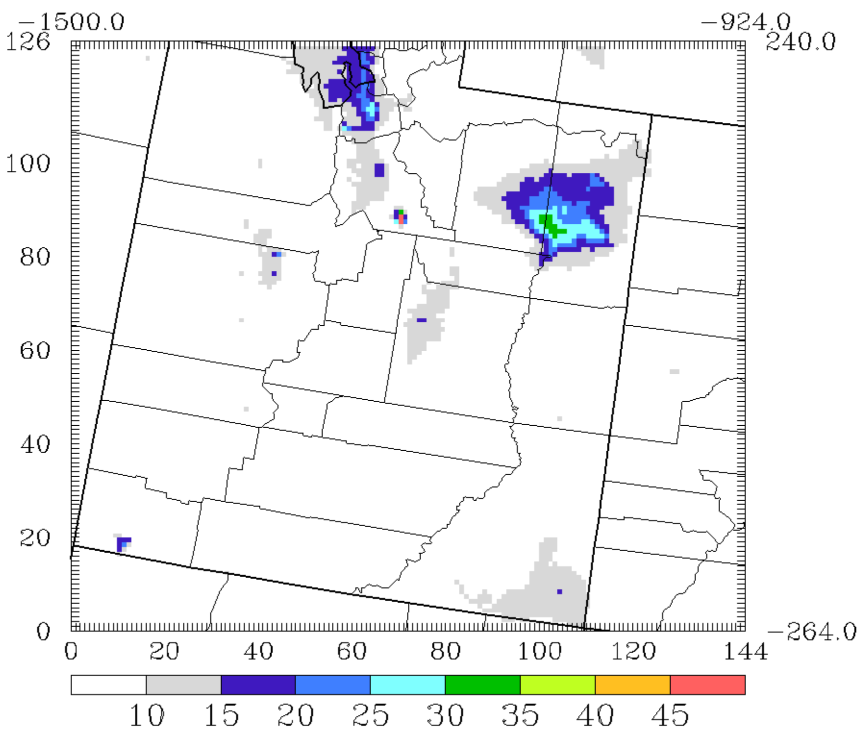

Figure 3-8: 98th Percentile (8th high) 24-hour Average $PM_{2.5}$ Concentration (ug/m^3) for Post Drilling Emissions Case Simulation.

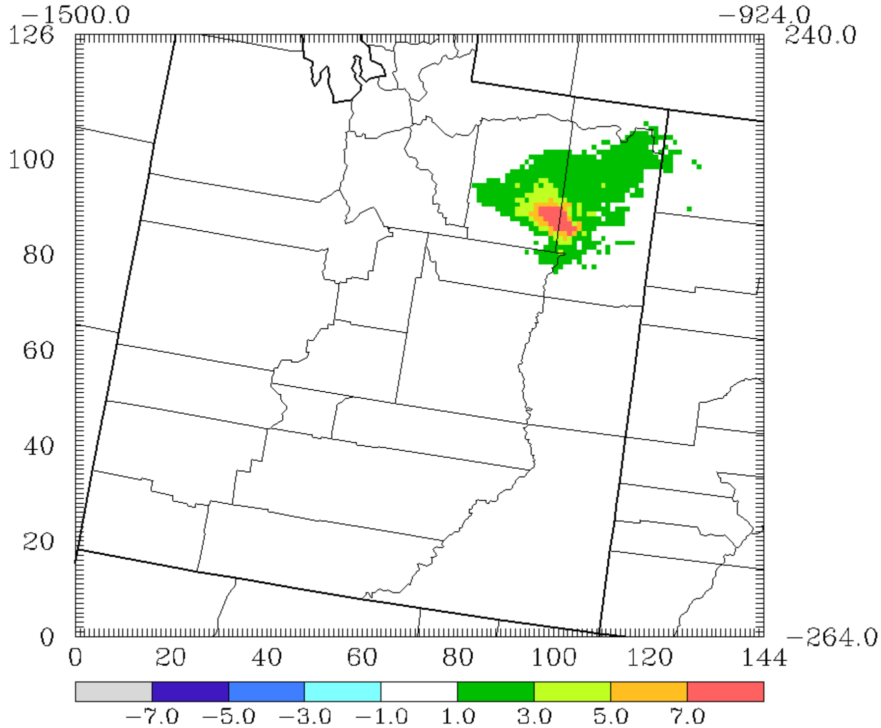

Figure 3-9: Difference in 98th Percentile (8th high) 24-hour Average $PM_{2.5}$ Concentration (ug/m^3) between Future Base Base Simulation and Maximum Emissions Case Simulations.

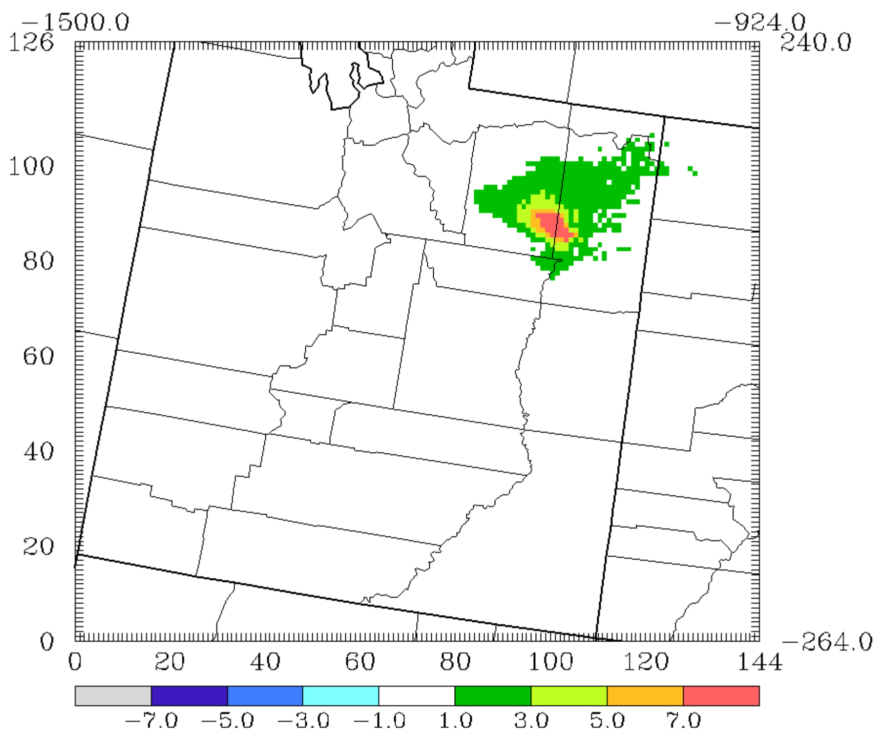

Figure 3-10: Difference in 98th Percentile (8th high) 24-hour Average $PM_{2.5}$ Concentration (ug/m^3) between Future Base Base Simulation and Post Drilling Case Simulations.

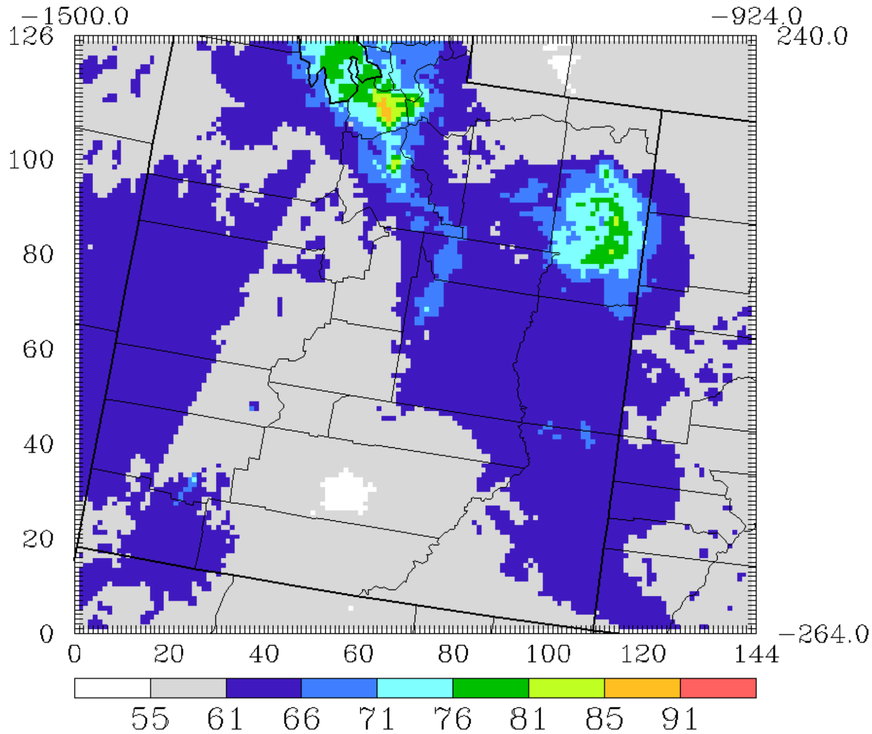

Figure 3-11: MATS Estimated Future Year 8-hour Average Ozone Design Value Concentration (ppb) for Future Base Simulation.

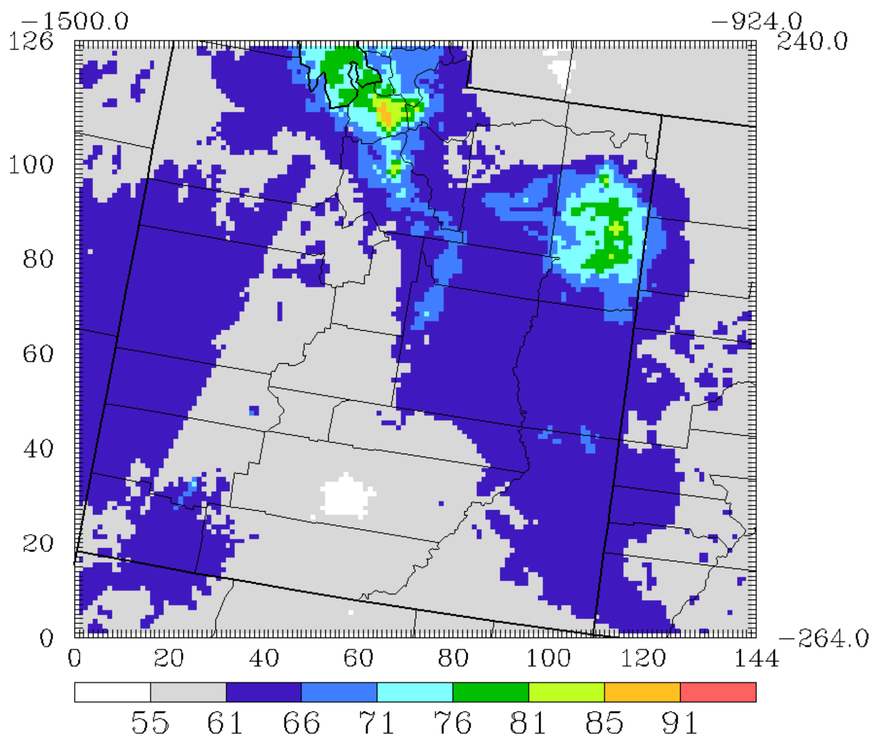

Figure 3-12: MATS Estimated Future Year 8-hour Average Ozone Design Value Concentration (ppb) for Maximum Emissions Case Simulation.

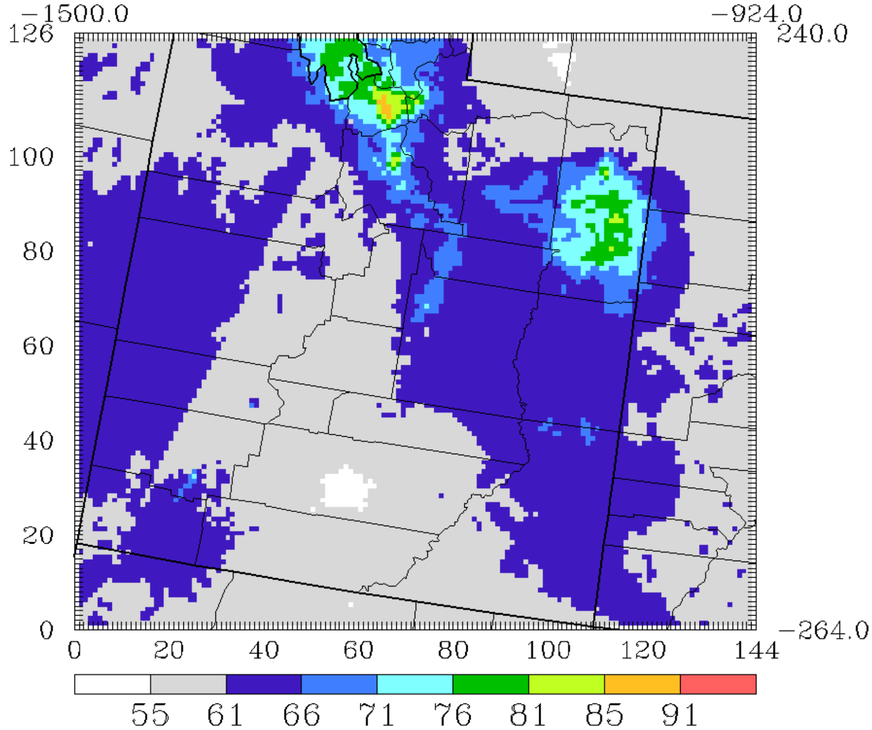

Figure 3-13: MATS Estimated Future Year 8-hour Average Ozone Design Value Concentration (ppb) for Post Drilling Case Simulation.

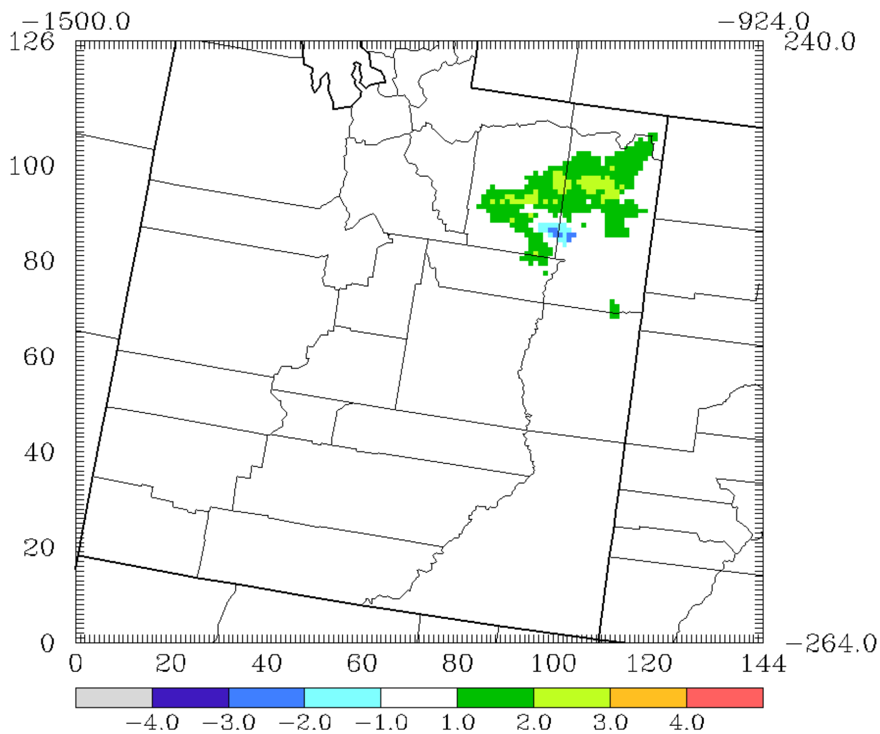

Figure 3-14: Difference in MATS Estimated Future Year 8-hour Average Ozone Design Value Concentration (ppb) Between Maximum Emissions Case and Future Base Case Simulations.

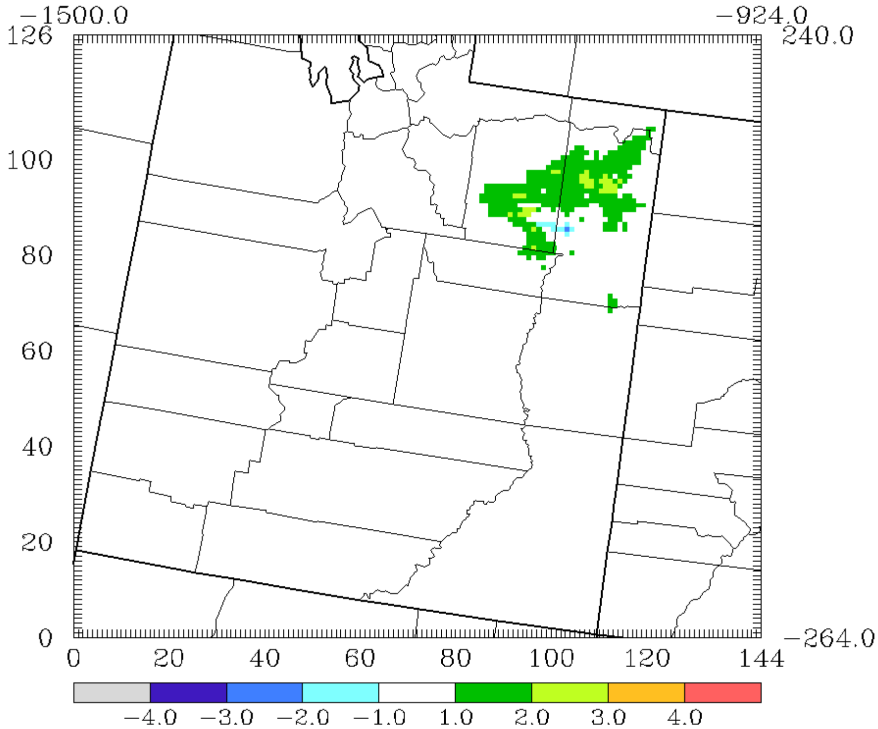

Figure 3-15: Difference in MATS Estimated Future Year 8-hour Average Ozone Design Value Concentration (ppb) Between Post Drilling Case and Future Base Case Simulations.

3.2 Sulfur and Nitrogen Deposition

Atmospheric deposition has been established as an Air Quality Related Value (AQRV) because of the ecological effects of increased nutrient loading and acidification resulting from airborne nitrogen and sulfur compounds deposited in sensitive areas. The effects of nitrogen and sulfur deposition on terrestrial and aquatic ecosystems are well-documented and have been shown to cause leaching of nutrients from soils; acidification of soils, groundwater, and surface waters; injury to high elevation vegetation; and changes in nutrient cycling and species composition. Related to acidification, acid neutralizing capacity (ANC) is a measure of the ability of a water body to neutralize acid deposition; reduction in ANC can be detrimental to the chemistry of sensitive aquatic ecosystems.

This section analyzes the potential nutrification and acidification impacts to terrestrial and aquatic ecosystems as a result of model-predicted nitrogen and sulfur deposition. For this analysis, nitrification and acidification impacts to terrestrial and aquatic ecosystems are analyzed at Class I areas, sensitive Class II areas, and sensitive lakes for all model scenarios.

The Deposition Analysis Thresholds (DAT) were developed by the Federal Land Managers for the analysis of deposition impacts associated with specific projects (FLAG 2010). The DATs represent screening level values for nitrogen and sulfur deposition from project-only emission sources below which estimated impacts are considered to be negligible. The DATs established for both nitrogen and sulfur in western Class I areas are 0.005 kg/ha/yr. This threshold was applied to differences in respective model-predicted deposition fluxes at Class I and sensitive Class II areas.

Total nitrogen and sulfur deposition fluxes are also used to estimate potential changes in ANC at sensitive lake receptors by following the procedure outlined in the USFS's *Screening Methodology for Calculating ANC Change to High Elevation Lakes* (USFS 2000). The calculated background ANC [ANC(o)] in units of equivalents (eq) and the acid deposition (H_{dep}) in units of eq, are used to calculate the change in ANC (percent) from a measured background for each sensitive lake.

To evaluate impacts, the ANC change (percent) is compared to a limit of acceptable change. The limit of acceptable change for ANC is a 10 percent change for lakes with a background ANC greater than or equal to 25 micro-equivalents per liter (μeq/L) and 1 percent for lakes with a background ANC less than 25 μeq/L. All the sensitive lakes identified for the ARMS Modeling Project have a background ANC greater than or equal to 25 μeq/L.

Model predicted nitrogen and sulfur deposition are presented in Table 3-15. The assessment area specific critical loads were taken from the ARMS impact analysis. In most cases the future base simulation and the two simulations that include the project emissions exceed the nitrogen deposition critical load. Project contributions exceed the nitogen DAT of 0.005kg/ha/yr at Arches NP, Dinosaur NM, Flaming Gorge, High Uintas Wilderness, the Uintah and Ouray Indian

Reservation and all sensitive lakes. The sulfur DAT was never exceeded. The peak nitrogen deposition impact is 0.067 kg/ha/yr and the peak sulfur deposition impact is 0.002 kg/ha/yr at the Uintah and Ouray Indian Reservation and Fish Lake.

Model predicted total annual acidification is presented in Table 3-16. The peak project impact on acidification value is estimated for the Maximum emissions case at the Uintah and Ouray Indian Reservation with an impact of 4.9 eq/ha/yr.

Model predicted impact on ANC of sensitive lakes is presented in Table 3-17. The limit for acceptable change is 10%. The impact of both project cases on all the sensitive lakes is much less than the limit. The peak impact is at Walk Up Lake in the Ashley National Forest with an impact of 1.0% for the Maximum Emissions case.

Table 3-15: Model Predicted Nitrogen and Sulfur Deposition for MB Future Base, Max Emissions and Post Drilling Proposed Action.

Receptor Site	Total Annual Nitrogen Deposition (kg N//ha/yr)						Total Sulfur Deposition (kg S/ha/yr)				
	Critical Load	Future Base	Max	Project Impact	Post Drill	Project Impact	Future Base	Max	Project Impact	Post Drill	Project Impact
Class 1 Areas											
Arches NP	3.0	**5.50**	**5.50**	**0.007**	**5.50**	**0.006**	0.82	0.82	0.000	0.82	0.000
Bryce Canyon NP	2.5	**5.00**	**5.00**	0.000	**5.00**	0.000	0.74	0.74	0.000	0.74	0.000
Canyonlands NP	3.0	2.59	2.59	0.003	2.59	0.002	0.65	0.65	0.000	0.65	0.000
Capitol Reef NP	2.5	**3.12**	**3.12**	0.001	**3.12**	0.001	0.59	0.59	0.000	0.59	0.000
Mesa Verde NP	3.0	**3.56**	**3.57**	0.001	**3.57**	0.001	1.55	1.55	0.000	1.55	0.000
Class 2 Areas											
Dinosaur NM	3.0	**3.39**	**3.43**	**0.038**	**3.42**	**0.033**	0.88	0.88	0.001	0.88	0.001
Flaming Gorge National Rec. Area	2.5	**3.38**	**3.40**	**0.021**	**3.40**	**0.018**	0.82	0.82	0.000	0.82	0.000
Goshute Indian Reservation	3.0	1.95	1.95	0.001	1.95	0.001	0.66	0.66	0.000	0.66	0.000
High Uintas Wilderness	2.5	**4.82**	**4.84**	**0.021**	**4.84**	**0.018**	1.14	1.14	0.001	1.14	0.001
Paiute Indian Reservation	2.5	**4.68**	**4.68**	0.000	**4.68**	0.000	0.92	0.92	0.000	0.92	0.000
Skull Valley Indian Reservation	3.0	2.95	2.95	0.004	2.95	0.003	0.76	0.76	0.000	0.76	0.000
Uintah and Ouray Indian Reservation	2.5	**5.03**	**5.10**	**0.067**	**5.09**	**0.058**	0.75	0.75	0.002	0.75	0.002
Sensitive Lakes											
Heart Lake, High Uintas WA	3.0	**5.03**	**5.05**	**0.021**	**5.05**	**0.018**	1.24	1.24	-0.001	1.24	-0.001
4D2-039, High Uintas WA	3.0	**6.41**	**6.45**	**0.035**	**6.45**	**0.031**	1.67	1.67	0.001	1.67	0.001
Dean Lake, High Uintas WA	3.0	**4.48**	**4.49**	**0.015**	**4.49**	**0.013**	1.03	1.03	0.000	1.03	0.000
Walk Up Lake, Ashley National Forest	3.0	**5.85**	**5.90**	**0.048**	**5.89**	**0.041**	1.31	1.31	0.002	1.31	0.001
4D1-044, High Uintas WA	3.0	**4.59**	**4.60**	**0.016**	**4.60**	**0.013**	1.17	1.17	0.001	1.17	0.001
Fish Lake, High Uintas WA	3.0	**6.15**	**6.19**	**0.038**	**6.19**	**0.032**	1.46	1.46	0.002	1.46	0.002

Highlighted values denote exceedence of the critical load or DAT

Table 3-16: Model Predicted Total Annual Acidification for MB Future Base, Max Emissions and Post Drilling Proposed Action.

Receptor Site	Total Annual Acidification (eq/ha/yr)				
	Future Base	Max	Project Impact	Post Drill	Project Impact
Class 1 Areas					
Arches NP	443.7	444.2	0.5	444.2	0.4
Bryce Canyon NP	403.8	403.8	0.0	403.8	0.0
Canyonlands NP	225.3	225.5	0.2	225.5	0.2
Capitol Reef NP	259.6	259.7	0.1	259.7	0.1
Mesa Verde NP	351.5	351.6	0.1	351.6	0.1
Class 2 Areas					
Dinosaur NM	296.7	299.4	2.8	299.1	2.4
Flaming Gorge National Recreation Area	292.9	294.4	1.5	294.2	1.3
Goshute Indian Reservation	180.9	180.9	0.0	180.9	0.0
High Uintas Wilderness	415.6	417.2	1.5	417.0	1.3
Paiute Indian Reservation	392.0	392.1	0.0	392.0	0.0
Skull Valley Indian Reservation	258.4	258.7	0.3	258.7	0.2
Uintah and Ouray Indian Reservation	406.1	411.0	4.9	410.3	4.2
Sensitive Lakes					
Heart Lake, High Uintas WA	437.1	438.5	1.4	438.3	1.3
4D2-039, High Uintas WA	562.6	565.2	2.6	564.9	2.3
Dean Lake, High Uintas WA	384.3	385.4	1.0	385.2	0.9
Walk Up Lake, Ashley National Forest	499.7	503.2	3.5	502.7	3.0
4D1-044, High Uintas WA	401.0	402.2	1.2	402.0	1.0
Fish Lake, High Uintas WA	530.5	533.3	2.8	532.9	2.4

Table 3-17: MB Future Base, Max Emissions, and Post Drilling Proposed Action Model-Predicted Impact on ANC of Sensitive Lakes.

Lake	Actual Watershed Area (hectares)[1]	Annual Precipitation (meters)[1]	Background ANC (ueq/L)[1]	N Deposition (kg/ha/yr)	S Deposition (kg/ha/yr)	ANC(o) (eq)	Hdep (eq)	ANC Change from Measurement (percent)
Future Base Cumulative								
Heart Lake, High Uintas WA	117	1.03	54.6	5.03	1.24	44085	51138	116.0%
4D2-039, High Uintas WA	174	0.89	65.16	6.41	1.67	67608	97898	144.8%
Dean Lake, High Uintas WA	122	1.1	51.4	4.48	1.03	46216	46890	101.5%
Walk Up Lake, Ashley National Forest	175	0.88	61.43	5.85	1.31	63383	87440	138.0%
4D1-044, High Uintas WA	59.6	1.01	64.98	4.59	1.17	26207	23900	91.2%
Fish Lake, High Uintas WA	220	0.88	104.5	6.15	1.46	135549	116713	86.1%
Maximum Emissions Project Impact								
Heart Lake, High Uintas WA	117	1.03	54.6	0.02	0.00	44085	169	0.4%
4D2-039, High Uintas WA	174	0.89	65.16	0.04	0.00	67608	455	0.7%
Dean Lake, High Uintas WA	122	1.1	51.4	0.01	0.00	46216	125	0.3%
Walk Up Lake, Ashley National Forest	175	0.88	61.43	0.05	0.00	63383	612	1.0%
4D1-044, High Uintas WA	59.6	1.01	64.98	0.02	0.00	26207	69	0.3%
Fish Lake, High Uintas WA	220	0.88	104.5	0.04	0.00	135549	620	0.5%
Post Drilling Project Impact								
Heart Lake, High Uintas WA	117	1.03	54.6	0.02	0.00	44085	148	0.3%
4D2-039, High Uintas WA	174	0.89	65.16	0.03	0.00	67608	396	0.6%
Dean Lake, High Uintas WA	122	1.1	51.4	0.01	0.00	46216	107	0.2%
Walk Up Lake, Ashley National Forest	175	0.88	61.43	0.04	0.00	63383	529	0.8%
4D1-044, High Uintas WA	59.6	1.01	64.98	0.01	0.00	26207	58	0.2%
Fish Lake, High Uintas WA	220	0.88	104.5	0.03	0.00	135549	533	0.4%

[1] Values taken from ARMS Impact Report.

3.3 Visibility

Under the Clean Air Act (CAA), visibility has been established as a critical resource for mandatory Class I areas. Particulate matter in the atmosphere contributes to visibility degradation by both scattering and absorption of visible light. The combined effect of scattered and absorbed light is called light extinction.

Visibility impacts were calculated using the IMPROVE equation as documented in the Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase 1 Report – Revised (2010)[10] which uses model computed pollutant concentrations to calculate light extinction as a function of relative humidity for large particles, small particles and sea salt particles. Relative humidity adjustment factors are required because some particles (e.g. ammonium sulfate and ammonium nitrate) can absorb water, increasing their size and light scattering. Site specific monthly relative humidity factors and background concentration data were taken from FLAG as were the annual natural visibility conditions.

Visibility results are presented in Table 3-18. Predictably, the higher impacts were for the Maximum emissions case. At Class 1 areas the project impacts the Arches National Park and Canyonlands National Park on 4 to 6 days over 1.0 Delta Deci-View (DDV). The project emissions impact the Arches National Park, Canyonlands National Park, and Capitol Reef National Park at over 0.5 DDV on 4 to 9 days, depending on the area. At sensitive Class 2 areas the project impacts Dinosaur National Monument, Flaming Gorge National Recreation Area, High Uintas Wilderness and Uintah and Ouray Indian Reservation on multiple days at greater than 1.0 DDV. At Class 1 areas the peak 98th percentile DDV is 0.66 at Arches National Park.

10 http://www.nature.nps.gov/air/Pubs/pdf/flag/FLAG_2010.pdf

Table 3-18: Number of Days with Delta-Deciview (DDV) Greater than 0.5 and 1.0 and 98th Percentile DDV for Future Base, MB Max. Emissions and Post Drilling.

Receptor Site	Maximum Emissions			Post Drilling		
	Days DDV > .5	Days DDV > 1.0	98th DDV	Days DDV > .5	Days DDV > 1.0	98th DDV
Class 1 Areas						
Arches NP	9	6	0.6623	8	5	0.5878
Bryce Canyon NP	0	0	0.0555	0	0	0.0526
Canyonlands NP	7	4	0.4643	7	2	0.4213
Capitol Reef NP	4	0	0.3573	3	0	0.3044
Mesa Verde NP	0	0	0.0993	0	0	0.0890
Class 2 Areas						
Dinosaur NM	124	97	4.5744	119	90	4.0334
Flaming Gorge National Recreation Area	94	61	3.2641	85	55	2.8662
Goshute Indian Reservation	0	0	0.0234	0	0	0.0214
High Uintas Wilderness	51	27	1.7481	43	23	1.5253
Paiute Indian Reservation	0	0	0.0471	0	0	0.0388
Skull Valley Indian Reservation	0	0	0.0514	0	0	0.0429
Uintah and Ouray Indian Reservation	362	340	13.2980	361	331	12.5086

4 Summary

One-atmosphere far-field photochemical modeling has been conducted for the Greater Monument Butte Project Proposed Action using the Models-3 Community Multi-scale Air Quality (CMAQ)photochemical modeling and the Air Resource Modeling Strategy (ARMS) modeling platform.

The far-field modeling results were analyzed to quantify the air impacts of the project emissions on, Ambient Air Quality Standards (NO_2, SO_2 Ozone, $PM_{2.5}$,PM_{10}), and Air Quality Related Values (ARQV) of Deposition, Visibility, and Acid Neutralization Capacity (ANC).

4.1 Ambient Air Quality

Ambient air quality impacts with and without the project were compared with applicable State and National Air Quality Standards. Although this is not a PSD increment project study, impacts were compared with Class 1 and Class 2 PSD Increment values in all regions to provide context for assessing the impact significance.

With the exception of ozone and 24-hour $PM_{2.5}$, the model predicts that concentrations with and without the project emissions will be below National and State Ambient Air Quality Standards (AAQS) all pollutants except ozone.

The model predicts that the fourth highest 8-hour daily maximum ozone concentration will exceed the standard in the Uinta Study Area and in the Uintah and Ouray Indian Reservation. No PSD increment value or other significance criteria has been established for ozone. The peak absolute impact on the fourth-highest concentration is estimated to be 1.6 ppb at the Dinosaur AQS station. On a relative basis the peak impact at a monitor is estimated to be 1.5 ppb at the Fruitland site and 1.4 ppb in unmonitored areas.

The model predicts that the 24-hour $PM_{2.5}$ standard of 35 ug/m^3 will be slightly violated with a value of 35.5 ug/m3 for the Maximum Emissions case in the Uinta Study Area. All other areas are estimated to be below the AAQS with or without project emissions.

The model predicts that the project impacts will be less than the most stringent Class 1 PSD increment values for all pollutant and averaging times except for 24-hour average $PM_{2.5}$ and PM_{10} where the most stringent Class 1 increment value is exceeded a few monitors, but the Class 2 increment value is not exceeded. At Class 1 areas the Class 1 PSD increment values are never exceeded.

4.2 Sulfur and Nitrogen Deposition

Sulfur and Nitrogen deposition impacts with and without the project were compared against applicable Deposition Analysis Thresholds (DAT) and nitrogen critical loads. At nearly all the sites, with and without the project emissions, the model estimates exceedences of the nitrogen critical load. The model estimates exceedence of the Class 1 nitrogen DAT of 0.005 kg/ha/yr at Arches NP, Dinosaur NM, Flaming Gorge, High Uintas Wilderness, the Uintah and Ouray Indian Reservation and all the analyzed sensitive lakes.

The sulfur DAT is exceeded at Dinosaur NM, the Uintah and Ouray Indian Reservation, Lake 3D2-039, Walk Up Lake and Fish Lake. The peak nitrogen deposition impact is 0.067 kg/ha/yr and the peak sulfur deposition impact is 0.002 kg/ha/yr at the Uintah and Ouray Indian Reservation and Fish Lake.

The peak project impact on acidification value is estimated for the Maximum emissions case at the Uintah and Ouray Indian Reservation with an impact of 4.9 eq/ha/yr. The limit for acceptable change in Acid Neutralization Capacity (ANC) is 10%. The impact of both project cases on all the sensitive lakes is much less than the limit. The peak impact is at Walk Up Lake in the Ashley National Forest with an impact of 1.0% for the Maximum Emissions case.

4.3 Visibility

Visibility impacts were calculated using the IMPROVE equation which calculates light extinction as a function of relative humidity for large particles, small particles and sea salt particles. Relative humidity adjustment factors are required because some particles (e.g. ammonium sulfate and ammonium nitrate) can absorb water, increasing their size and light scattering. Site specific monthly relative humidity factors and background concentration data were taken from FLAG.

At Class 1 areas the project impacts the Arches National Park and Canyonlands National Park on 4 to 6 days over 1.0 Delta Deci-View (DDV). The project emissions impact the Arches National Park, Canyonlands National Park, and Capitol Reef National Park at over 0.5 DDV on 4 to 9 days, depending on the area. At sensitive Class 2 areas the project impacts Dinosaur National Monument, Flaming Gorge National Recreation Area, High Uintas Wilderness and Uintah and Ouray Indian Reservation on multiple days at greater than 1.0 DDV. At Class 1 areas the peak 98th percentile DDV is 0.66 at Arches National Park.